

RICK WILLIAMS

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## **RAPTOR RESEARCH**

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# EXTERNAL SEX CHARACTERS OF HARRIS' HAWKS IN WINTER

by

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## Abstract

From 585 individual Harris' Hawk (*Parabuteo unicinctus harrisi*) banded in winter in Texas, plus 3 recoveries and 4 found dead, we conclude that, although there are no apparent plumage differences between males and females, there are practicable sex criteria based on body size. Males take a U.S. Fish and Wildlife Service band size 7a, females 7b (discrepancy, 1.8%). Males fit into holding tubes of 106 mm inside diameter, females 128 mm (about 2% discrepancy). Sexing by weight and wing measurement is most accurate when birds are segregated according to age. There was no overlap in weights in the younger age classes and only 0.3% among adults. Wing chord overlapped by 0.5 to 2.0% and flattened wing by 0 to 1.3%, depending upon age. By combining several criteria, one can be virtually certain about sex diagnosis.

Nineteen *P. u. harrisi* from Tamaulipas agreed with the Texas material; 32 *P. u. superior* from Sonora showed no overlap in weight or in either wing measurement.

Ten birds from Texas, one from Tamaulipas, and two from Sonora showed possible anomalies in molt or pattern of the outer two primaries that confused aging. There was also a suggestion that fully adult primaries might not be attained until the second year.

## Introduction

That the males of most falconiforms are smaller than the females is hardly news—but how much smaller? How much overlap? Is the proportion the same among juveniles? Is the difference precise enough to serve as a useful sex character? We examined these questions in Harris' Hawks that we banded in recent years. The last question is particularly important because both sexes have similar, if not identical, plumage.

## Methods

We banded Harris' Hawks during short periods in the autumn of 1965 and the winters of 1969–1971, and more intensively in the winters of 1973–1976: *harrisi* in south Texas (593), trans-Pecos Texas (5), Tamaulipas (20); and *superior* (34) in Sonora, for a total of 652. In addition we have weights and/or measurements from 3 birds retrapped in subsequent winters plus one autumn and 4 winter road kills, all from south Texas. Most of our data therefore come from live-caught birds rather than from internally sexed specimens.

Some selection of data has been necessary. Since the subspecies *superior* is larger than *harrisi* (Brown and Amadon 1968), we have not lumped them. In dealing with weights and measurements we have excluded autumn birds (14) and treated the birds from Tamaulipas separately, in order to have a uniform sample of 592 winter birds from Texas. Hawks were processed in the field, sometimes under difficult conditions.

As a result, a few data were omitted or discarded, and the number of birds in each category may not agree with the others or with the total banded.

In analyzing weights and measurements, it became clear that age was a complicating factor. Northern raptors have a well-defined and relatively short breeding season with correspondingly predictable timing of molt and growth. Within age and sex classes, individuals in winter do not differ widely. Not so the Harris' Hawk. We suspect that, despite a major breeding season in summer, there are a few breeding in every month of the year. During each of the 7 months for which we have data—September, October, December through early April—we have found birds in completely immature, intermediate, and adult plumage. Thus immatures may reach adulthood at any month of the year, and winter populations run the gamut of age classes.

Juvenal and adult plumages are distinctively different (fig. 1). We recognize three age classes: immatures, recorded as Im—those in which all primaries, secondaries, and rectrices are juvenal even though the body molt may have started (generally only a few feathers); immature molting to adult, as Im-Ad, in which wing and/or tail molt has begun; and adult, as Ad, recognizable by the absence of juvenal flight and tail feathers and the presence of one or more generations of adult feathers.

The Im-Ad's are further divided according to the extent of primary molt. Length of chord and of flattened wing is determined by primaries 6 and 7, whose tips project the farthest. Adult primaries are longer than juvenal. Birds whose immature primaries have not yet molted as far as number 7 are recorded as Im-Ad with immature  $LP_7$  (we measure the left wing). Those whose molt has proceeded farther are Im-Ad with adult  $LP_7$ . Age classification is thus based on wing and tail feathers only. Our method of recording molt has been described elsewhere (Hamerstrom, F. and F. 1971).

We have used four presumed sex characters. The common (though not absolute) agreement among them plus the shapes of the curves (i.e., bimodal distribution with little overlap) of weights and measurements lead us to believe that the criteria are valid and can be used to define simple and practicable means of sexing Harris' Hawks in the field.

The four sex criteria are: tube size (diameter of the tubes in which we hold the hawks during processing), band size, weight, and wing measurements, both flattened and chord. In the following discussion, each criterion is compared with the *combination*—always a clear majority—of the other criteria. We assume that the true sex is shown by the combination and that disagreement indicates an inadequacy in the criterion under test.

## Results

*Tube Size.* Upon removing a hawk from a trap, we put it into a holding tube devised by the Cedar Grove Ornithological Station. The upper half of such a tube is made of a metal can with both top and bottom removed. The lower half is an identical can with only the top cut out and with breathing holes punched about  $\frac{1}{4}$  in. apart around the outer edge of the bottom. The two cans taped together make one tube. Diurnal raptors thus held are in a darkened place with gentle but firm restraint. They remain quiet, are able to defecate, and come out with feathers undamaged even after some hours.

When we started banding Harris' Hawks, we learned that tube size was a quick first indication of sex, and a good one. Among our collection of holding tubes were

two sizes into which Harris' Hawks fitted nicely, males into tubes made of 46-oz. juice cans measuring 4 3/16 in. (106 mm) inside diameter, females into tubes made of 2-lb. coffee cans 5 1/16 in. (128 mm) diameter. We recorded the size of tube for each of 334 catches from 1974 to 1976. Eleven (3.3%) were in off-size tubes. Seven adults among 173 males were weighed in female tubes. In an unknown but high proportion of cases, however, this happened because all the male tubes already had birds in them. Three of 161 females were weighed in male tubes. One of these was an immature female recorded as 944 g, probably an error; 2 were at the low end of the scale for females (an 802 g immature and an 811 g Im-Ad) and show genuine overlap.

Thus, although our tube-size sample is smaller than those for the other criteria, and the degree of reliability cannot be as exactly stated, it is plainly useful. An unusually large adult male might fit into either a male or a female tube, and a very small immature or Im-Ad female—or an underweight bird—might fit as well in a male tube. Our data suggest, however, that such instances would be very few, on the order of 2%. Further data from banding, weighing and measuring would clarify this point.

We have no record of individual tube sizes for the 20 hawks banded in Tamaulipas, but 13 males and 10 females in Sonora were all in tubes of the appropriate size.

**Band Size.** Females have stouter tarsometatarsi than males. We took no direct measurements, but the size of the band that fits properly clearly shows the difference. We used standard U.S. Fish and Wildlife Service bands of both butt-end and lock-on type; 7a for males and 7b for females. Of 326 male and 288 female *harrisi* banded in Texas and Tamaulipas, only 11 (1.8%) took the "wrong" size. Four males were banded with 7b's and 7 females with 7a's. The discrepancies seem not to be correlated with age: 2 males were adult, one was Im-Ad with immature LP<sub>7</sub>, and one was immature; 2 females were adult, one was Im-Ad with immature LP<sub>7</sub>, 3 were immature, and one was age unknown.

In our small sample of 19 males and 14 females of *superior*, one adult female (3.0%) took a 7a.

Excluded from the discussion above are two birds with broken and healed legs, each of which took a larger than normal band because of enlarged tarsi.

**Weight.** All weights were taken on a double-beam balance. Birds were generally weighed in the tubes already described; a nylon stocking made a good emergency substitute.

Most crops were empty. If not, we estimated the weight of the crop contents and from time to time forced the crop contents up and weighed them as a check on our estimates. We deducted crop contents in excess of an estimated 10 g from gross weights.

Weights are summarized in table 1 and figure 2. Males averaged about 300 g less than females in all three age classes. Mader (1975) found the same relationship for *superior* in Arizona. In Texas adults (N=397), the weight curves approach bell shape for each sex. Females in both younger age classes show a flatter and broader distribution, perhaps reflecting incomplete growth. Immature male weights show a bell-shaped curve, but both male and female Im-Ad's show a puzzling second peak near the heavy extreme of their curves.

As might be expected, each successive age class averaged heavier than the younger



one, thus precluding a lumping of classes. This progression showed even when the Im-Ad's were divided on the basis of wing development. Those with juvenal primaries through the seventh averaged lighter in weight, in both sexes, than those somewhat older birds whose molt had progressed further. We cannot say when maximum weight is reached, but it appears to be close to, or after, the primaries have fully molted into adult plumage.

There was no overlap in the weights of male and female immatures and Im-Ad's (tables 1, 2, and 3, fig. 2). One adult male exceeded the minimum of adult females by 4 g; the overlap is 0.3%.

The weights of 19 *harrisi* from Tamaulipas did not differ greatly from the weights of the Texas birds (table 2).

The Sonoran birds (*superior*, table 3) fell mostly within the ranges of the Texas birds, although the minima were always greater, and one adult female exceeded the Texas maximum by 6 g. Except for adult males, averages for other age classes of *superior* were higher than for *harrisi*, although the age-group sample sizes are so small as to weaken the comparison. Mader (1975) did not separate age groups in his data for *superior* in Arizona. In table 3 we have combined our Sonoran age classes and entered Mader's values for comparison.

Mader (1975) found no overlap between males and females in his Arizona weights, nor did we in Sonora. We suspect, however, that a larger sample from Sonora would at least narrow the gap.

Table 1. Weights (in grams)—Texas, Winter<sup>1</sup>

	No.	Male Range	Av.	No.	Female Range	Av.
Immature	37	536-755	636.8	39	789-1137	935.1
Im-Ad						
All	46	581-756	652.8	58	811-1123	963.2
Im LP <sub>7</sub>	35	607-730	648.6	45	811-1123	950.3
Ad LP <sub>7</sub>	11	581-756	667.4	13	875-1120	1007.8
Adult	220	550-829	689.7	177	825-1173	997.7
Total	303	536-829		274	789-1173	

<sup>1</sup>In this table and all those following, Im = immature, Ad = adult, LP<sub>7</sub> = 7th primary of left wing. Im LP<sub>7</sub> = LP<sub>7</sub> is immature (juvenal), Ad LP<sub>7</sub> = LP<sub>7</sub> is adult.

Table 2. Weights (in grams)—Tamaulipas, Winter

	No.	Male Range	Av.	No.	Female Range	Av.
Immature	0			0		
Im-Ad	4	598-682	646.2	2	868-942	905.0
Adult	9	647-722	669.0	4	940-1066	992.5
Total	13	598-722		6	868-942	

Table 3. Weights (in grams)—Sonora, Winter

	No.	Male Range	Av.	No.	Female Range	Av.
Immature	3	652-752	717.3	3	959-1055	1017.0
Im-Ad	2	725-745	735.0	1	985	985
Adult	13	621-758	687.8	10	955-1179	1039.0
Total	18	621-758	697.9	14	955-1179	1030.4
Arizona <sup>a</sup>	37	634-877	725	14	918-1203	1047

<sup>a</sup>Mader (1975)

*Wing chord.* We routinely held the left wing, bent at the wrist, along a meter stick to measure the chord. Data for the Texas birds are given in table 4 and figure 3.

Slight overlap occurred in all age classes except Im-Ad's with immature LP<sub>7</sub>. Among immatures, one female (1.3%) was 3 mm less than the male maximum of 330 mm. Two males (2.0%) equalled or exceeded by 5 mm the female minimum of 326 mm for all Im-Ad's together; when this class was subdivided, there was no overlap among those with immature LP<sub>7</sub> but one male (4.2%) equalled the female minimum of 331 mm in Im-Ad's with adult LP<sub>7</sub>. Among adults, 2 males (0.5%) equalled or exceeded by 2 mm the female minimum of 340 mm. The largest discrepancy (4.2%) is in the smallest sample; the rest are small enough to show that chord measurement is a good, though not infallible, sex criterion.

When the Im-Ad's with immature LP<sub>7</sub> are plotted with the immatures (fig. 4), the curves for both sexes are smoothed, and the averages changed by only 0.1 mm for males and 0.8 mm for females. There is no pronounced shift toward the right (longer wing) side of the curve, and the averages for the two groups separately are nearly the same. Adding the few Im-Ad's with adult LP<sub>7</sub> to the adults (fig. 4) makes little change in averages, probably because of the great discrepancy in sample size, but does shift both curves slightly to the left. One could expect such a shift in weights, but since the primaries stop growing once they are hard-penned, this suggests that full development of the adult primaries might not occur until the second year. The Im-Ad's with adult LP<sub>7</sub> do in fact fall between immatures and adults in average chord measurement in both sexes, but especially in females (table 4).

Chord measurements from Tamaulipas are given in table 5. Such differences as there are, compared with Texas birds, are probably due to the small sample size. However, one adult male exceeded the Texas maximum by 3 mm.

Sonoran chord measurements paralleled weights: one adult female exceeded the Texas maximum by 2 mm, the others fell within the Texas ranges but had higher minima and averages. A comparison with Mader's (1975) Arizona values is shown in table 6. The Arizona values are somewhat higher than the Sonoran.

Mader (1975) found no overlap in measurements of the chord in Arizona, nor did we in Sonoran birds whether age classes are lumped or separated.

*Flattened Wing.* After measuring the chord, the tip of the wing was held firmly on the end of the meter stick, and the folded wing pressed down against it to measure the flattened wing. With the obvious difficulties there are in getting a good measure-



**Table 4. Wing chord (in mm)—Texas, Winter**

	No.	Males Range	Av.	No.	Females Range	Av.
Immature	37	299-330	311.7	38	327-367	348.3
Im-Ad						
All	45	298-331	314.0	55	326-368	348.0
Im LP <sub>7</sub>	34	298-324	311.9	42	326-360	346.8
Ad LP <sub>7</sub>	11	309-331	320.7	13	331-368	352.0
Adult	221	303-342	324.0	176	340-383	360.9
Total	303	298-342		269	326-383	

**Table 5. Wing chord (in mm)—Tamaulipas, Winter**

	No.	Male Range	Av.	No.	Female Range	Av.
Immature	0			0		
Im-Ad	4	305-325	317.3	2	338-359	348.5
Adult	8	315-345	326.1	4	347-365	358.0
Total	12	305-345		6	338-365	

**Table 6. Wing chord (in mm)—Sonora, Winter**

	No.	Male Range	Av.	No.	Female Range	Av.
Immature	3	318-319	318.3	3	352-363	358.7
Im-Ad	2	321-323	322.0	1	354	354
Adult	13	323-347	333.0	10	353-385	372.6
Total	18	318-347	329.3	14	352-385	368.3
Arizona <sup>a</sup>	37	318-360	335	14	362-385	375

<sup>a</sup>Mader (1975)

ment of the chord of a live and strong bird, we thought that the flattened-wing measurement would give more consistent results. To the extent that the measurement shows somewhat less overlap than the chord, that was true (table 7), but the resulting curves (fig. 5) are not always smoother.

As with the chord, immatures and Im-Ad's with immature LP<sub>7</sub> were virtually the same within sexes, adults showed the longest measurements, and Im-Ad's with adult LP<sub>7</sub> fell between: they were longer than immature wings but not as long as full adults.

There was little overlap between the sexes within age groups—none among adults (although the gap is only 1 mm) or among Im-Ad's with either adult or immature LP<sub>7</sub>. When the Im-Ad's are not separated, one female (1.0%) was 1 mm less than the

male maximum. One immature female (1.3%) was 5 mm less than the male maximum. Flattened-wing measurement is thus also a good sex criterion—slightly better than chord but not as good as winter weight.

Measurements of flattened wing from Tamaulipas and Sonora are given in tables 8 and 9. Measurements from each state follow the pattern set by the chord. Mader (1975) did not measure flattened wings, so no comparison with Arizona *superior* is possible.

**Table 7. Flattened wing (in mm)—Texas, Winter**

	No.	Males Range	Av.	No.	Females Range	Av.
Immature	37	307-340	320.7	38	335-380	360.3
Im-Ad						
All	45	308-339	323.0	57	338-381	359.8
Im LP <sub>7</sub>	34	308-334	320.8	44	338-371	358.2
Ad LP <sub>7</sub>	11	314-339	329.7	13	344-381	365.3
Adult	221	313-350	333.2	176	351-397	373.6
Total	303	307-350		271	335-397	

**Table 8. Flattened wing (in mm)—Tamaulipas, Winter**

	No.	Male Range	Av.	No.	Female Range	Av.
Immature	0			0		
Im-Ad	4	316-334	325.5	2	346-366	356.0
Adult	8	323-349	332.8	4	354-375	368.5
Total	12	316-349		6	346-375	

**Table 9. Flattened wing (in mm)—Sonora, Winter**

	No.	Male Range	Av.	No.	Female Range	Av.
Immature	3	327-329	328.3	3	366-379	373.7
Im-Ad	2	330-334	332.0	1	371	371
Adult	13	333-358	343.5	10	370-400	385.9
Total	18	327-358		14	366-400	

*Tail Length.* There may well be sex-linked differences in tail length in birds in fresh plumage. However, the entire white tip—about 30 mm—may be worn off, and one finds all stages in between. For that reason, we have not used tail length as a sex criterion.

*Birds of Uncertain Age.* Six males and 4 females from Texas (1.7% of sample), plus one female from Tamaulipas and one male and one female from Sonora, present a

special problem. These birds have white speckling at the base of one or both of the outer primaries, as in the case of juvenal primaries. For the present we are not sure whether these birds are Im-Ad's that have not yet completely molted, adults with retained juvenal primaries, or adults with aberrant primaries. We call them "Im-Ad or Ad-Ad?" and for the present have excluded them from the tables and graphs. If they are adults, as we now suspect, their addition to the group of adults would make little difference to the present values. Averages would be only slightly changed, and the maxima and minima—which determine overlap between measurements of males and females—would not change. If they are Im-Ad's, the addition of ten Texas birds to the sample "Im-Ad with adult LP<sub>7</sub>" which now numbers only 24, would be more appreciable. The new sample would then include 17 males and 17 females:

Weight—Males average 677.9 g, range 581–756; females average 986.8 g, range 862–1120. No overlap.

Chord—Males average 322.6 mm, range 309–333; females average 353.9 mm, range 331–370. There would be an increase of 2 mm in the maxima for both males and females (one each); one female (331 mm) would now be less than the males' maximum, or a discrepancy of 2.9% instead of the present 4.2%.

Flattened wing—Males average 331.8 mm, range 314–342; females average 367.0 mm, range 344–381. The males' maximum would be increased by 3 mm, but there would still be no overlap.

### *Summary and Conclusions*

Harris' Hawks do not have sexually distinct plumages but do differ in several body measurements. From our sample of 592 *harrisi* handled in winter in Texas we conclude that four external sex criteria have so little overlap that they are individually reliable within rather small tolerances. Data in the text define the extent of separation or overlap. As a field tool, we suggest that if any 3 of the following 4 criteria agree, sex determination can be considered virtually certain. Known discrepancies (i.e., overlap) in individual criteria, when present, are indicated in parentheses:

1. The bird fits nicely into a tube with interior diameter of 106 mm—male; interior diameter 128 mm—female (about 2%).

2. U.S. Fish and Wildlife Service band 7a fits properly—male; 7b—female (1.8%).

3. Weight (by age classes):

Immature (no adult primaries or rectrices): to 760 g—male; 780 g and more—female.

Im-Ad (immature molting to adult—some primaries or rectrices incoming or adult): to 760 g—male; 800 g and more—female.

Adult (no juvenal or incoming primaries or rectrices): to 829 g—male; 825 g and more—female (0.3%).

Since measurements of chord and flattened wing are so closely related, they are treated as one criterion:

4a. Chord (by age classes):

Immature: to 330 mm—male; 327 mm and more—female (1.3%).

Im-Ad: to 331 mm—male; 326 mm and more—female (2.0%).

Adult: to 342 mm—male; 340 mm and more—female (0.5%).

4b. Flattened wing (by age classes):

Immature: to 340 mm—male; 335 mm and more—female (1.3%).

Im-Ad: to 339 mm—male; 338 mm and more—female (1.0%).

Adult: to 350 mm—male; 351 mm and more—female.

Where there is overlap in one criterion, even though small, it is particularly important to use as many as possible of the other criteria in order to have a clear majority. Age determination is in many cases a prerequisite in interpreting weights and wing measurements.

The 19 *harrisi* from Tamaulipas fit with the Texas material reasonably well, and the Texas criteria would probably also serve winter banders there. The 32 Sonoran *superior*, somewhat larger than *harrisi*, are rather few for establishing clear criteria. It is certainly suggestive that there was, as with Mader's (1975) sample, no overlap in winter weights or chord measurements. Combining the two sets of data, we tentatively suggest 880 g as a maximum for males and 915 g as a minimum for females; among chord measurements, 360 mm or less equals male and 362 mm or more, female.

It is possible that with more data one could use only two age classes—those with immature seventh primary and those with adult seventh primary. At present, the immatures and Im-Ad's with immature seventh primary could be combined, but the present sample of immatures with adult seventh primary is too small to be clearly interpretable. Enlargement of that particular sample would also clarify the possibility that fully adult primaries are not acquired until the second year. These problems, and the uncertainty that still exists concerning the few "Im-Ad or Ad-Ad?" birds, plainly mean "back to the banding grounds."

### *Acknowledgments*

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Figure 1. Wing of Im-Ad (immature molting to adult) Harris' Hawk female illustrating (a) shape of the wing, (b) difference between immature (barred) and adult (dark, virtually unmarked) flight feathers, and (c) that adult primaries and secondaries are longer than immatures. This bird shows the uniformly dark breast of the adult; immatures have dark breasts with conspicuous light streaks.

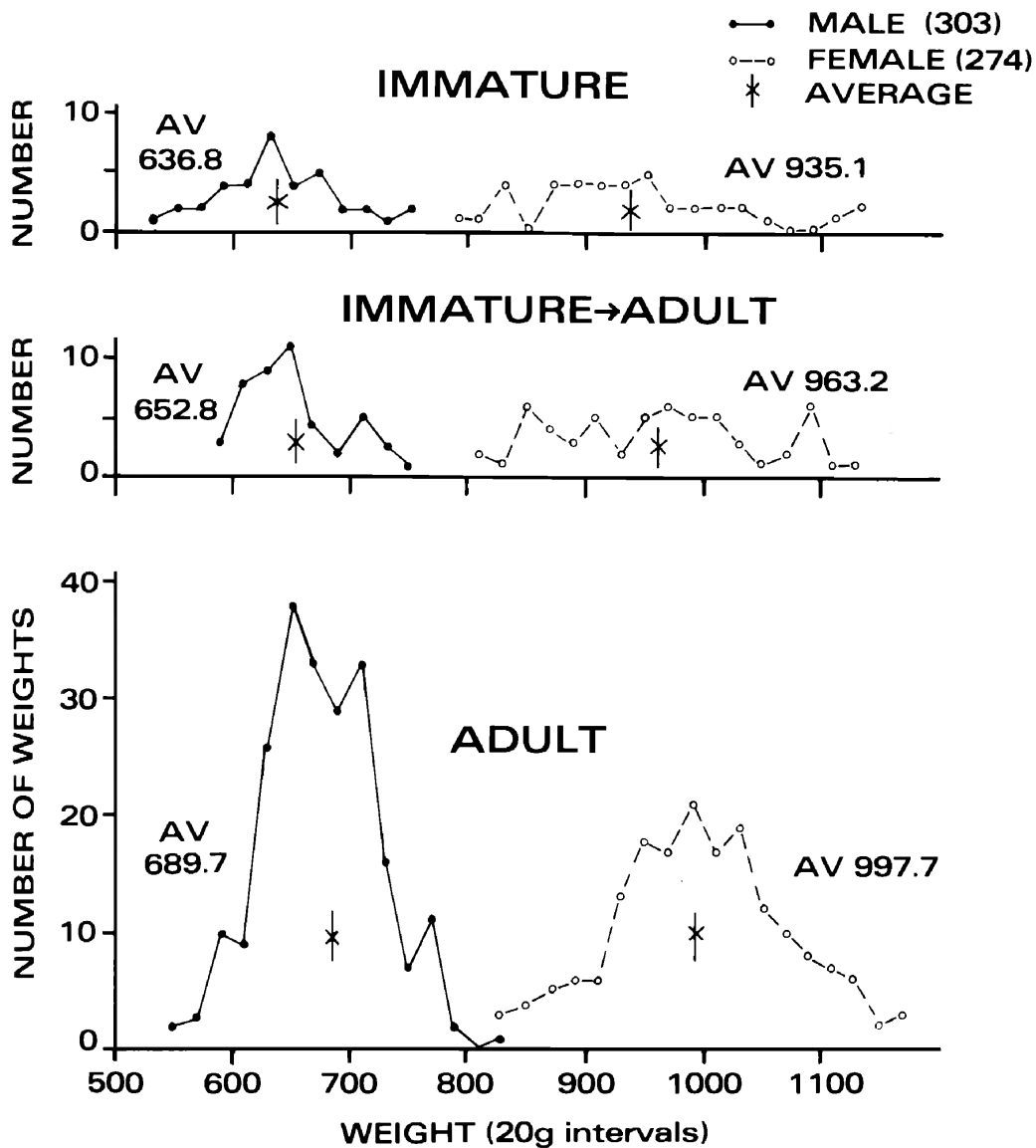
**HARRIS' HAWK, TEXAS, WINTER**

Figure 2. Winter weights of Harris' Hawks banded in Texas. Crop contents in excess of 10 g have been deducted.



## HARRIS' HAWK, TEXAS, WINTER

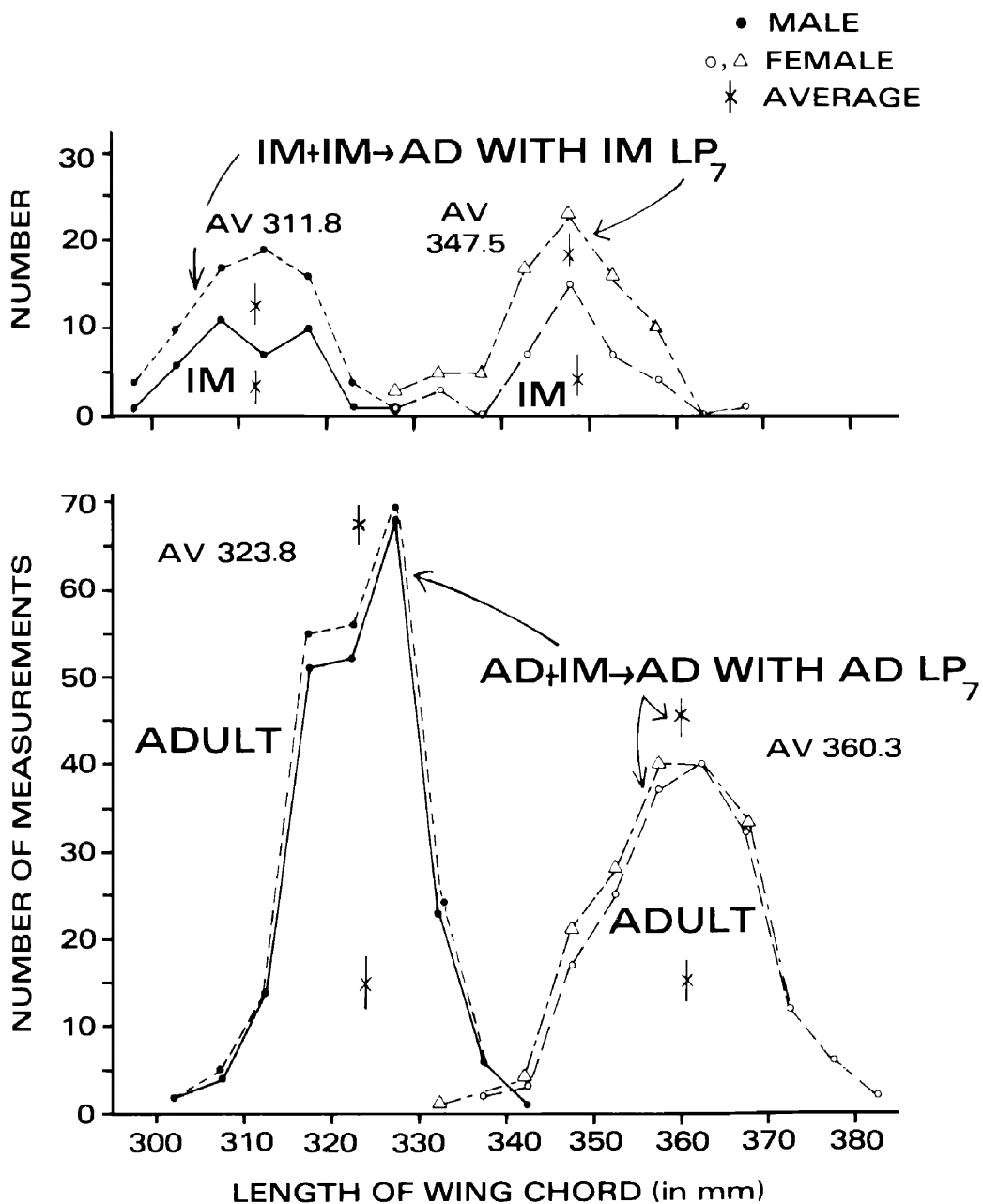


Figure 3. Length of wing chord of winter-banded Texas Harris' Hawks.

## HARRIS' HAWK, TEXAS, WINTER

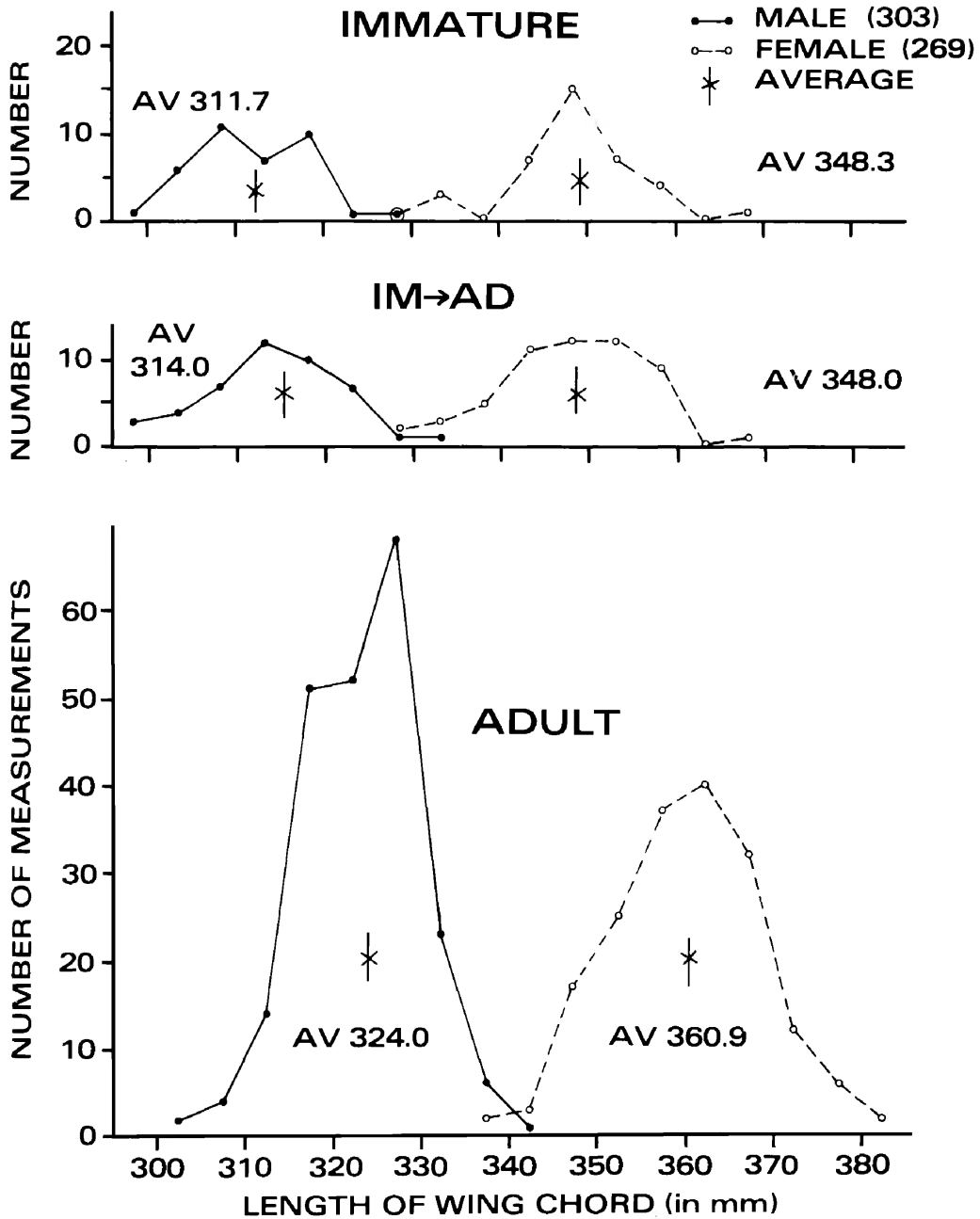


Figure 4. Chord measurements recombined: *Upper*—Immatures alone and immatures plus immatures molting to adult plumage but still with immature seventh primary. *Lower*—Adults alone and adults plus immatures molting to adult plumage, already with adult seventh primary.

## HARRIS' HAWK, TEXAS, WINTER

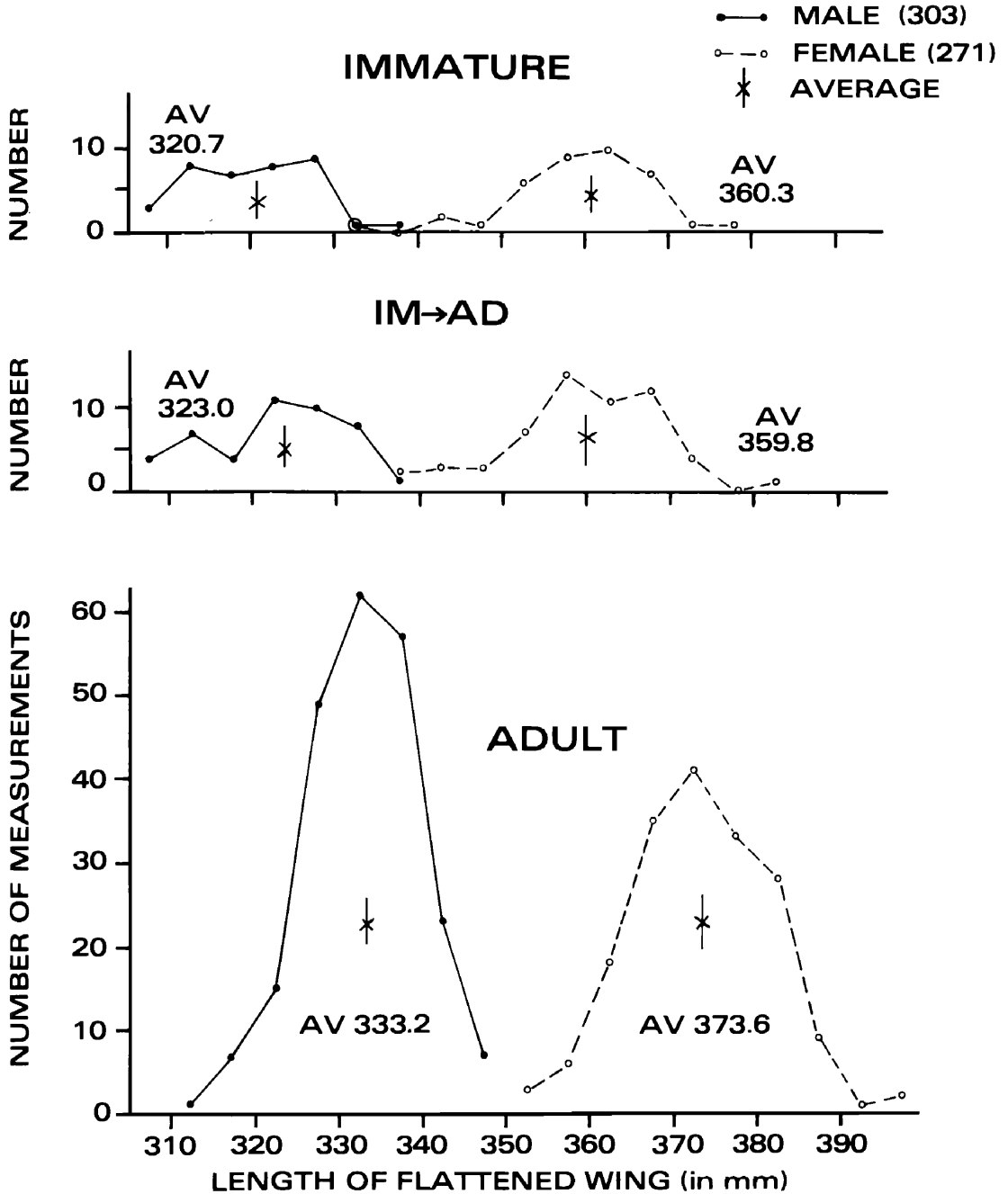


Figure 5. Length of flattened wing of winter-banded Texas Harris' Hawks.

# NEST SITE SELECTION BY THE BROAD-WINGED HAWK IN NORTH CENTRAL MINNESOTA AND WISCONSIN

by

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## *Abstract*

Twenty-nine nests in several parts of Minnesota and Wisconsin were compared. Nests were primarily in the oak-aspen sere, 35 years old and older. Nesting density was about one pair per 2 square miles (3.2 km<sup>2</sup>). Nests were in the first suitable crotch in the lower one-third of the canopy, within 408 feet (124 m) of an upland opening and within 468 feet (143 m) of a wet area.

## *Introduction*

The Broad-winged Hawk (*Buteo platypterus*) has not been studied extensively. In publications from 1880 to 1930 most observations of nesting habitat were in general terms, except for nest heights and dimensions. Burns (1911) stated that the ideal area in Pennsylvania for Broad-winged Hawks consisted of upland hillsides, and swamps, well covered with mixed hardwood stands interspersed with small clearings and roadways with water areas available. Banks (1884), Currie (1901), and Riley (1902) indicated that the nest is always placed in a crotch of the main trunk. Eighty records from the continent-wide Cornell Nest Record Card Program give nest heights ranging from 8 to 70 feet (2 to 21 m), the average being 38 feet (12 m).

My study was carried out as part of an investigation into the effects of Ruffed Grouse (*Bonasa umbellus*) management upon wildlife in general, primarily on the Crow Wing Natural History Area (20 miles [32 km] southeast of Brainerd, Minnesota) and adjacent properties. The area is characterized by hills and outwash plains, the result of glacial activity more than 16,000 years ago. About 28 percent is wetland, ranging from marsh to spruce-fir bog. The remainder is covered with second-growth stands of mixed hardwoods.

One part of the study was to find and describe nest sites of raptors. After two years of observation a pattern for the nest site requirements of the Broad-winged Hawk was apparent. In order to test the site description for places other than the study area, Broad-winged nest sites were observed near Cloquet, Bethel, Lake Itasca, and Brainerd in Minnesota, and near Plainfield and Stevens Point in Wisconsin. The study period extended from March 1971 through August 1974.

## *Methods*

I made systematic searches in areas in which hawk sightings were reported by workers involved in projects on the Crow Wing Area, as well as in areas of previous hawk nests. I looked for hawks on all stick nests. When urates or whitewash, feathers, or fresh greenery were found near a nest or when a hawk was observed frequently in the vicinity, the nest tree was climbed.

I measured height of nest above ground, diameter and depth of the nest, and diameter at breast height (dbh) of the nest tree. Nest materials, species of nest tree, configuration of branches supporting the nest, and egg measurements were recorded. Periodic checks through the nesting season provided data on number of young, food brought to the young, and nest sanitation. Young were banded prior to fledging. Distances from the nest tree to the nearest wet area, trail, road, or other upland opening, and to the nearest conifer were measured.

I compared woodland densities around nest sites by using a modification of the wandering quarter method described by Catana (1963). Ten trees with a dbh of four inches (10 cm) or greater in each of the four cardinal compass directions, with the nest tree as the focal point, were selected for evaluation. Four inches (10 cm) dbh was chosen because trees of this size and larger contribute to the forest crown. Density figures were calculated in trees per acre (trees per hectare).

### Results

Twenty-nine nest sites were observed during the study period. Eleven were on the primary study area; 13 were active when investigated.

The nests found were composed of loosely organized twigs of aspen, oak, and birch. Oak was the most frequently used nest tree in this study (table 1).

The support of the nest is a crotch or branching of the main trunk of the tree at a height which is within, but close to, the lower limit of the crown (table 2). Seventy-five percent of all forking configurations were three-way or four-way. The single nest

**Table 1. Nest support trees used by Broad-winged Hawks in north central Minnesota and Wisconsin, 1971-1974.**

Species	Number	% Occurrence	Av. dbh (in.)	Av. ht. (ft.)
Oak	12	41	9.7 (25 cm)	31 (9 m)
Aspen	6	21	9.3 (24 cm)	34.2 (10 m)
Birch	5	17	9.9 (25 cm)	26 (8 m)
Ash	2	7	9.5 (24 cm)	40 (12 m)
Maple	1	3	13.3 (34 cm)	25 (8 m)
Basswood	1	3	7.5 (19 cm)	26 (8 m)
Red pine	1	3	10.5 (27 cm)	35 (11 m)
Jack pine	1	3	15 (38 cm)	45 (14 m)

**Table 2. Branch configuration of 28 nest trees used by Broad-winged Hawks in north central Minnesota and Wisconsin, 1971-1974.**

Branching	Number	% Occurrence	Av. dbh (in.)	Av. ht. (ft.)
2 way	1	3.6	10 (25 cm)	30 (9m)
3 way	11	39.3	10.7 (27 cm)	33.2 (10 m)
4 way	10	35.7	9.0 (23 cm)	29.0 (9 m)
5 way	6	21.4	9.7 (25 cm)	33.5 (10 m)

with a two-way fork support was in an aspen in which a deep V provided a large support area.

Two things were apparent when looking at Broad-winged Hawk nests and location in the woods: (1) the close proximity of the nest to an upland opening, and (2) the presence of a wet area near the nest. The types of upland openings and the average distance from the nest are given in table 3. The average distance for all nests from an upland opening was 138 feet (42 m). No nests were found more than 408 feet (124 m) from an upland opening.

Wetlands near the nest were of six types (table 4); none was farther than 468 feet

**Table 3. Upland forest opening type nearest to 29 Broad-winged Hawk nests in north central Minnesota and Wisconsin, 1971-1974.**

Type of opening	Number of occurrences	% of occurrence	Av. distance to nest (ft.)
Woodland trail	20	69	72 (3-162) 22 m (1-49 m)
Paved road	4	14	224 (120-396) 68 m (37-121 m)
Gravel road	3	10	379 (360-408) 115 m (110-124 m)
Woodland field	2	7	258 (252-264) 79 m (77-80 m)

**Table 4. Wetland type nearest to 29 Broad-winged Hawk nests in north central Minnesota and Wisconsin, 1971-1974.**

Type of opening	Number of occurrences	% of occurrence	Av. distance to nest (ft.)
Wooded swamp <sup>1</sup>	14	48	116 (3-330) 35 m (1-101 m)
Shrub swamp <sup>1</sup>	8	28	250 (66-468) 76 m (20-143 m)
Shallow fresh <sup>1</sup> marsh	4	14	224 (84-396) 68 m (26-121 m)
Deep fresh <sup>1</sup> marsh	1	3	210 (64 m)
Pool <sup>2</sup>	1	3	258 (79 m)
Lake <sup>3</sup>	1	3	360 (110 m)

<sup>1</sup>Wetland types, United States Fish and Wildlife Service classification system (Shaw and Fredline 1956).

<sup>2</sup>Less than 5 acres, without vegetation, 1-2 feet in depth (.3-.6 m).

<sup>3</sup>More than 10 acres, deeper than 4 feet (1.2 m).



(143 m), and the average distance was 220 feet (67 m). All had two things in common: standing water, and the presence of frogs.

In this area, the forest type preferred by the Broad-winged Hawk was an oak-aspen sere. Stand density and species frequency at 10 nests on the Crow Wing Area are given in table 5. Average stand density was 82 trees per acre (204 per hectare), red oak being the predominant species. Increment borings indicate that the trees which the Broad-winged Hawk used for nesting were between 35 and 50 years of age.

**Table 5. Stand density at ten Broad-winged Hawk nests, Crow Wing Natural History Area, 1971-1974.**

Nest Tree	Stand Density Trees/Acre	Species Density of Site Dominant Species	% of Stand
Ash	229 (566/ha)	Oak	23
Aspen	122 (301/ha)	Aspen	15
Aspen	158 (390/ha)	Aspen	55
Aspen	213 (526/ha)	Oak	25
Red Oak	254 (627/ha)	Aspen	55
Red Oak	111 (274/ha)	Oak	25
Red Oak	184 (454/ha)	Oak	60
Red Oak	317 (783/ha)	Maple	15
Bur Oak	283 (699/ha)	Aspen	50
Paper Birch	172 (425/ha)	Oak	28
		Aspen	45
		Oak	35
		Birch	45
		Maple	28
		Oak	43
		Aspen	28
		Oak	45
		Aspen	28
		Ash	28
		Aspen	23
		Oak	50
		Oak	40

### *Discussion*

The height of the nest was governed by the forest crown structure. Only one of 29 nests was in the top of a tree. The others were in the lower one-third of the crown and in the first support site available above the lower limit of the crown. Bent (1937) stated that the Broad-winged Hawk nests in the most abundant and characteristic large tree in the area. Matray (1974) found that 12 of 14 nests in the Adirondacks were in yellow birch. Nesting trees in my study were not the most numerous or conspicuous in the area. The tree used for nesting appeared to be one that had an adequate support and was within 408 feet (124 m) of an upland opening and 468 feet (143 m) of a wet area.

Upland openings appeared to provide the primary food. Small mammals, birds, amphibians, reptiles, and insects made up the diet, with small mammals being the major portion, as determined by analysis of nest material and pellets collected at nest.

Broad-wings were often seen perched at the edge of wooded roads and trails. Roadways are used by many forms of wildlife. Six 2-acre (.8-hectare) small-mammal live capture and marking studies lasting 10 days each gave information on sizes and movements of prey populations. Each observation area was divided by a roadway or trail with traps on both sides to determine whether the roads were barriers to movement or if small mammals moved back and forth across them. Mammals captured were toe clipped for identification upon recapture. Small mammal activity and movement did occur across the openings. Also noted was that a large number of the captures of small mammals were adjacent to the openings.

Nest setback appears to be related to the amount of noise and disturbance at the opening. Table 3 shows that woodland trails were nearest and that gravel roads had the greatest nest distance or setback. Woodland trails, at the onset of nesting, were usually wet and inaccessible. Paved roads are accessible, but vehicles moving along these roads are fairly quiet. Two nests were near fields under cultivation, but resultant tractor noise occurred late in the nesting season.

Amphibians appear to be a vital part of the prey base for Broad-winged Hawks. This explains the value of wet areas in nest-site selection. Small birds and insects which frequent swamps also are a part of the Broad-winged diet. There was much variability as to distance from the nest to the wet area, but 468 feet (143 m) was the maximum (table 4). Wooded swamps which provided perch sites for hunting were the closest wetland type.

Broad-winged Hawks on the Crow Wing Area have a breeding density of one pair per 2 square miles (3.2 km<sup>2</sup>). The activity center is a breeding, nesting, feeding territory which is defended until the young are fledged and the nest is abandoned. Adults which appeared in the same activity center in subsequent years nested in a different part each year. The young, as indicated from banding returns, did not return.

Matray (1974) stated that Broad-winged Hawks in his study area in the central Adirondack Mountains utilized fresh sprigs of several tree species in their nests. This contradicts Burns (1911) who stated that only one kind of leaf material is used in each nest. Nests on the Crow Wing Area were lined on the bottom with bark. Those which showed activity shortly after the birds arrived were decorated with conifer sprigs. Later, fresh sprigs of aspen and oak leaves were used, both in the same nests at some locations. Eight nests that were constructed after leaf emergence did not have conifer in them. The species of conifer used seemed to be a peculiarity of the individual hawks in a particular activity center. In activity centers in use two or more years when conifers were used the species was constant. The conifer used was not always the species nearest to the nest. For example, at one activity center on the Crow Wing study area where Broad-winged nests were located three out of four years, white pine sprigs were in the nest. White pine was not present in the general vicinity of the nest sites—red pine was!

### *Implications for Forest Wildlife Management*

Major emphasis of forest game management is for Ruffed Grouse and white-tailed deer (*Odocoileus virginianus*). This involves the setting back and maintenance of aspen woodlands in a 40-year rotation. Game management also involves the erection of

nest boxes and blasting of small potholes for Wood Duck (*Aix sponsa*) and American Goldeneye (*Bucephala clangula*) production.

I believe these operations will maintain the Broad-winged Hawk in the forest ecosystem. The ideal size of manipulation blocks for grouse and deer is 10 acres (4 hectare). The openings and the trail system that evolve from logging will maintain the needed upland openings. The maintenance of wet areas in the forest for ducks will also provide the required wet areas for Broad-winged Hawks.

As long as a harvest rotation is developed which provides interspersation at the closest intervals, the Broad-winged Hawks will be able to nest in the 40-year-old stands and hunt in the younger areas. These young areas have the necessary substantial small mammal populations. Where woodland waterfowl are part of the forest prescription, in order to maintain nest sites for ducks, older trees of the oak sere will not be cut.

Some people are concerned that forest game management advocates an aspen monotype. I do not foresee this occurring in this part of the country with the present equipment, markets, and stand variabilities. Under present methods of clear-cutting, part of the stand will come back with oak and birch, as well as aspen, if the stand contains these components prior to cutting.

Forty percent of forest land ownerships are held in small parcels by private individuals with varying interests which help in maintaining forest stand diversity (Gullion pers. comm.). This in turn will insure the maintenance of the Broad-winged Hawk as part of the forest ecosystem.

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**PROTOCALLIPHORA AVIUM (DIPTERA)  
MYIASIS IN GREAT HORNED OWLS, RED-TAILED HAWKS,  
AND SWAINSON'S HAWKS IN NORTH DAKOTA**

by

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**Abstract**

In Grand Forks County, North Dakota, in 1970-1971, I found the following numbers of nestlings parasitized by *Protophthora avium* (Diptera): Great Horned Owl, 1; Red-tailed Hawk, 34; and Swainson's Hawk, 2. I found cutaneous myiasis in the auditory meatus, nape and neck, axillary area, anal area, and a rectrix follicle. Aggregations of eggs in the axillary areas and uniformly-sized larvae in the aural cavities of Red-tailed Hawks suggest that eggs of *P. avium* were deposited directly upon the host. Larvae remained in the ears of a captive Red-tailed Hawk until they were mature. Nestlings with several sites of infestation were visibly weaker, smaller, and more poorly developed than other nestlings. Sibling attacks on nestling Red-tailed Hawks with heavy infestations of *P. avium* may result in death.

**Introduction**

North American raptors are well-known hosts for Bird Nest Screw Worm Flies, *Protophthora* sp. (syn. *Apaulina* Hall; Diptera). Protophthorids have been found in the nares, ear canals, axillae, feather sheaths, ventral surfaces or nests of 11 species of hawks and owls (Shannon and Dobrosky 1924, Sargent 1938, Hill and Work 1947, Hamerstrom and Hamerstrom 1954, Meng 1954, Lee and Ryckman 1954, Hickey 1969, Seidensticker and Reynolds 1971, Swartz pers. comm. 1976). Sargent (1938) suggested that the infestation of the Red-tailed (*Buteo jamaicensis*) and Red-shouldered (*B. linneatus*) Hawk nests is nearly 100 percent. According to Sabrosky (pers. comm. 1971), all hawks and owls should be good hosts.

The pathology of these infestations has not been well established. Sargent (1938) and Hamerstrom and Hamerstrom (1954) did not observe a loss of auditory acuity with infestations of the aural canal in Red-tailed, Red-shouldered or Cooper's (*Accipiter cooperii*) Hawks. Sargent also reported that normal feathers developed on a Red-tailed Hawk nestling with myiasis of the nape and crown. Cooper's Hawks with aural infestations did not appear to be appreciably weakened (Meng 1954). Seidensticker and Reynolds (1971) did not attribute any mortality to *Protophthora* sp., although nearly all Red-tailed Hawk nestlings observed were infested. However, Hill and Work (1947) suspected that these larvae were responsible for the death of a young American Kestrel (*Falco sparverius*). Young of the Marsh Hawk (*Circus cyaneus*) died when larvae (unidentified, probably protophthorids) penetrated the brain by way of the nares (Hamerstrom and Hamerstrom 1954).

In 1970-1971, I investigated the significance of *Protophthora* sp. myiasis in the nesting biology of the Red-tailed Hawk and the Great Horned Owl (*Bubo virginianus*) in Grand Forks County, North Dakota. Additional observations were made on

nestlings of the Swainson's Hawk (*B. swainsoni*) in 1971.

### Methods

Nestling raptors were examined to estimate the number of *Protocalliphora* larvae and eggs, to observe the sites and period of infestation, and to determine any injurious aspects of myiasis. Nests were examined for eggs, larvae, and pupae. There were 9 Great-horned Owl nests, 1 Swainson's Hawk nest, and 19 Red-tailed Hawk nests under observation. In these nests, young of Great Horned Owls and of Swainson's Hawks were examined at ages 2-3 and 5-6 weeks; young of Red-tailed Hawks were examined each week from age 1 week to age 6 weeks. Periodic attempts were made to observe egg-laying by *Protocalliphora* sp. from a blind at a Red-tailed Hawk nest in 1970 and 1971.

Larvae periodically collected in the field from nestlings and nest substrates were preserved in 70 percent ethyl alcohol. In 1970, I collected mature larvae as they dropped from a Red-tailed Hawk nestling confined in a cage with a bare floor. These larvae were placed in a container on a sterile substrate of equal parts sand, loam, and vermiculite. The container was placed in a fine mesh cage and the substrate kept moist at room temperature. In 1971 mature larvae were collected from the three species of raptor nestlings and nest material and placed in small jars with perforated tops containing shredded laboratory paper toweling. The toweling was kept moist and maintained at ambient room temperature. As adult flies emerged, they were killed and preserved in 70 percent ethyl alcohol. Both methods utilized to rear adults from larvae appeared to be equally successful.

In the field, larvae were removed from the ears of two nestling Red-tailed Hawks on two different occasions. These nestlings were subsequently examined for signs of reinfestation.

### Results and Discussion

One of 14 Great Horned Owl nestlings examined in 1971 was parasitized with *Protocalliphora*. This myiasis was also present in 34 of 36 Red-tailed Hawks in 1970 and 1971, and in the 2 Swainson's Hawk nestlings examined in 1971 (table 1). I observed the earliest infestation on 20 May 1971, in the Great Horned Owl nestling. The latest infestation was on 11 August 1971, in a Swainson's Hawk nestling. Thus, adult *Protocalliphora* sp. were active for at least 83 days in 1971, and I was able to observe and collect several generations. Adult flies were hatched from mature larvae taken from the ears of a captive Red-tailed Hawk nestling in 1970, and from the ears and bodies of 13 Red-tailed Hawk nestlings and 1 Great Horned Owl nestling in 1971. Adults were also hatched from mature larvae taken from the substrate of the Swainson's Hawk nest in 1971. All adult protocalliphorids raised from mature larvae were identified as *P. avium*, and the other larvae collected or observed were apparently of the same species (Sabrosky pers. comm. 1971).

The numbers of larvae present on infested nestlings varied. Red-tailed Hawk nestlings with only aural myiasis usually had a few large, or many small larvae, numbering 5-40. Larvae between 5.0 mm and 7.5 mm were observed in all lesions. Few immature larvae were found in the interior of the nests although often large numbers of mature larvae and pupae were present. I estimated that there were 300-400 *P. avium* larvae and pupae in one Red-tailed Hawk nest. In this nest both nestlings were heavily parasitized at most foci of infestation.

**Table 1. Loci of infestation in nestling Great Horned Owls, Red-Tailed Hawks and Swainson's Hawks parasitized by *Protocalliphora avium*, 1971, Grand Forks County, North Dakota**

Loci of Infestation	14 Great Horned Owls <sup>a</sup>	36 Red-tailed Hawks <sup>b</sup>	2 Swainson's Hawks <sup>c</sup>
None	13	2	0
Auditory Meatus	1	34	2
Axilla	0	15	2
Nape and Neck	0	7	2
Anal Area	0	4	2
Retrix Follicle	0	1	0

<sup>a</sup>9 nests

<sup>b</sup>19 nests; includes 7 nestlings observed in 1970, 5 of which were infested in the auditory meatus

<sup>c</sup>1 nest

In 1970, *P. avium* myiasis occurred only as an infestation of the aural cavity. Infestations in Red-tailed Hawks began at approximately one week of age. Eventually larvae plugged and stretched the auditory meatus. The ear opening and surface of the ear canal were covered with a red-brown exudate, and the area surrounding the ear was inflamed and swollen. It appeared that this condition irritated the nestlings, which were frequently observed shaking and scratching their heads. Infestations of the aural cavity occurred until nestlings were 4–5 weeks old.

In 1971, in addition to aural myiasis, 15 Red-tailed and 2 Swainson's Hawks were observed with myiasis in the axillary areas (fig. 1), nape and neck, and in the anal area. Cutaneous myiasis appeared as scabby, denuded areas with larvae enclosed in small dermal pockets of down and dried exudate. An unusual condition was seen in a Red-tailed Hawk nestling (fig. 2). Several larvae had invaded a retriex follicle and destroyed the developing feather. The opening to this cavity was sealed with exudate. Nestlings were first parasitized in the auditory meatus, with subsequent infestations in the axilla, nape and neck, anal area, and retriex follicle. This sequence, however, was not always complete. Infestations occurred in Red-tailed Hawks and Swainson's Hawks at age 3–4 weeks, with recovery at age 4–5 weeks as the mobility of the nestlings increased. However, some sites were denuded or feathers developed poorly. Of the five sites of parasitization, the presence of protocalliphorid larvae in feather follicles is reported here for the first time.

Hamerstrom and Hamerstrom (1954) suggest that hot, wet weather may enhance *Protocalliphora* sp. myiasis. The additional sites of *P. avium* myiasis which occurred in 1971 may be explained by the mean daily humidity of 77 percent as compared to 70 percent as a 10-year mean for June. Also, frequent precipitation which occurred in early June 1971 may have forced Red-tailed Hawks to brood newly hatched young for lengthy periods. Assuming that *P. avium* eggs or larvae were present on the nestlings, their survival may have been aided by the increased warmth and stationary aspect of their host.

Data from this study indicate that parasitization by *P. avium* may be an infrequent event in Great Horned Owls. On the other hand, the incidence of myiasis in Red-tailed Hawks and Swainson's Hawks approaches 100 percent as suggested by Sargent (1938). The average hatching date of Red-tailed Hawks was 4 June, 2 months later



than the hatching date of most Great Horned Owlets. At this time, adult *P. avium* had already emerged and been active for several weeks. Therefore, the occurrence of a parasitized Great Horned Owlet in this study may be explained by its late hatching date of 22 April.

*P. avium* females apparently laid eggs directly on nestling Red-tailed Hawks. Flies were observed entering the ears of two nestlings from which larvae had been removed. Subsequently, each ear cavity was infested within one day by approximately 40 uniformly sized larvae, each 2.5 mm in length. In addition, small clumps of eggs were observed several times near the axillary areas of nestlings.

Meng (1954) reported that *Protocalliphora* sp. eggs are deposited along the edge of the nests, and that larvae subsequently find their way into the ear openings. However, Rausch (1972) observed an aggregation of larvae in a single locus on the head and speculated that *P. hirudo* eggs might be deposited directly on a host. Females of *P. avium* may prefer the ear canal to other areas of the raptor body or nest for deposition of eggs because the ear canal provides warmth, moisture, protection, and a readily available food supply for their larvae. The enlarged ear openings covered with exudate resulting from initial infestations may attract other *P. avium* females and thus enhance continuous reinfestation, as in this study.

Although Sargent (1938), Boyd (1951) and Meng (1954) reported that the larvae feed intermittently and do not remain in the ear, only mature larvae dropped from the ears of my captive Red-tailed Hawk. The Hamerstroms (1954) similarly gathered mature larvae as they dropped from the ears of two Cooper's Hawk eyasses in a screened cage, and further concluded that maggots spend the entire time from hatching until pupation within the hawk's ear. Sabrosky (pers. comm. 1976) suggested that larvae safely situated in a body cavity or sheltered niche might remain in situ, though probably disengaging their mouth parts.

In 1970 when myiasis was limited to the ears, it did not visibly retard the development or impair the hearing of 2 captive Red-tailed Hawk nestlings. Similar to observations made by Hamerstrom and Hamerstrom (1954), the nestling Red-tailed Hawks were able to respond to a feeding whistle. When maggots dropped from the ears, or were removed by hand, no inflammation or secondary infection of the auditory meatus was evident. Larvae of *P. avium* may produce bacteriostatic secretion similar to that of *Cuterebra* sp., *Cephenemyia* sp., *Oestrus* sp., and *Gasterophilus* sp. (Landi 1960).

In 1971, when additional sites of myiasis occurred, the development and survival of raptor nestlings seemed to be adversely affected. Of 15 Red-tailed Hawk nestlings with several sites of myiasis, only 5 survived to fledge. All of these nestlings were visibly weaker, smaller, and less well developed than nestmates which had only aural infestations. On 3 occasions, I observed Red-tailed Hawk nestlings pecking and biting the heads of more heavily parasitized siblings. After one attack, I removed the victim for more detailed observation: the scalp was split and bleeding and the nape denuded; and I counted 213 *P. avium* larvae in the ears, axillae and flank, retriex follicle, and nape and neck. This nestling died approximately one hour after its removal from the nest. Five other Red-tailed Hawk nestlings had similar wounds and wounds at other sites at which larvae of *P. avium* were present. The health and condition of these nestlings deteriorated until they died, approximately one week after receiving the wounds. Similarly, the weaker and more heavily parasitized Swainson's Hawk nestling disappeared at age 4-5 weeks. Nestlings that were weakened by additional infestations were probably less able to compete for food and to protect themselves

from their siblings. Thus, in this study it appears that 6 of 36 Red-tailed Hawk nestlings died from infestations of *P. avium* and sibling attacks.

### *Acknowledgments*

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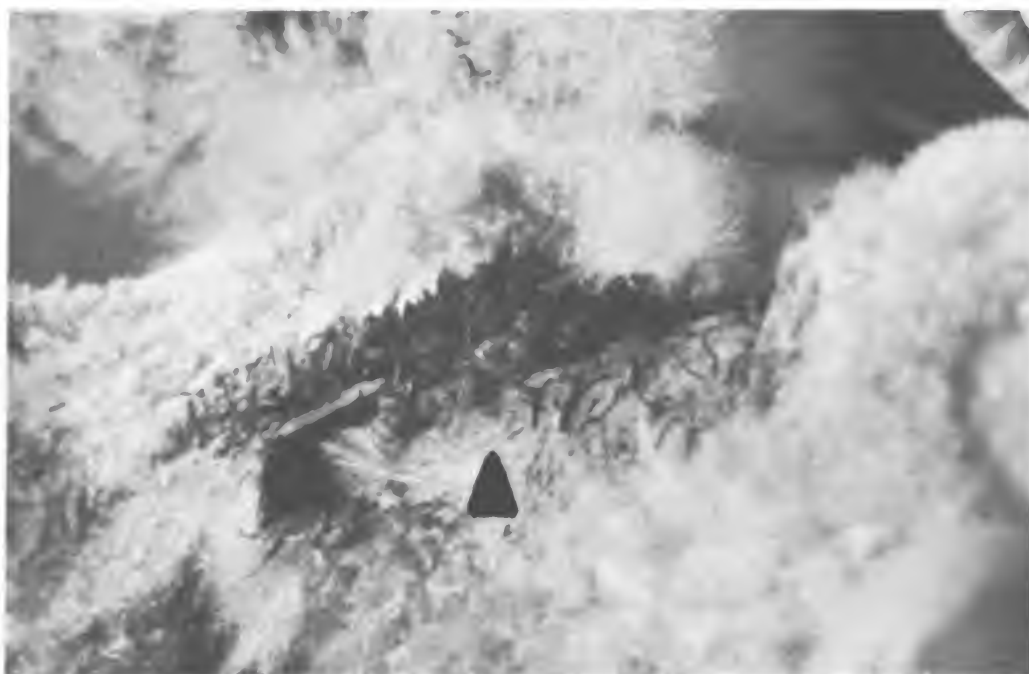


Figure 1. Larvae of *P. avium* in right axilla of nestling Red-tailed Hawk (see arrow); leg of nestling is at right; nape at upper left.

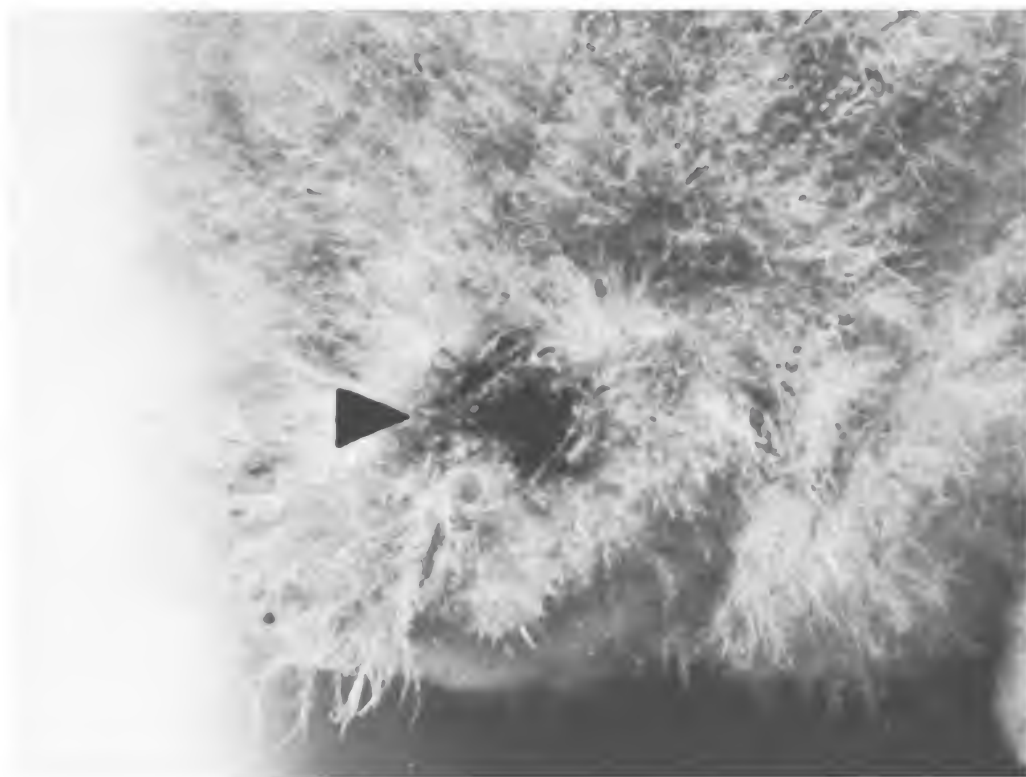


Figure 2. Cavity in tail of nestling Red-tailed Hawk caused by entrance of *P. avium* larvae with subsequent destruction of rectrix follicle (see arrow).

# STUDIES ON THE KARYOTYPE OF THE RED-TAILED HAWK (*BUTEO JAMAICENSIS*)

by

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## Abstract

Feather pulp from growing body feathers of Red-tailed Hawks (*Buteo jamaicensis*) located at the Raptor Center at the University of California, Davis, was treated in a hypotonic solution and fixative, then squashed and stained with Giemsa. The resulting spreads showed a majority of 34 pairs ( $2n=68$ ). The sex chromosomes were the fourth pair of the series; the female had heterogametic and the male homogametic pairs. The Common buzzard (*Buteo buteo*), reported by an earlier investigator, had a diploid number of 68 with the sex chromosome pair number as fourth in the series. Analytical methods showed that subjective judgment of the relative size of the chromosomes is fairly accurate, though ideally it would be best to analyze before the karyotypes are permanently mounted.

## Introduction

Birds of prey are not always sexually dimorphic. Ease of selection for breeding pairs in captivity has been handicapped for some less dimorphic species. The usual method of sexing raptors is by weight; yet many birds have weights that fall in an overlap range between males and females. This project was undertaken to provide essential information for the breeding project at the University of California, Davis's Department of Avian Sciences' Raptor Center, and to obtain the karyotype of a common North American raptor, the Red-tailed Hawk (*Buteo jamaicensis*).

Another criterion for this project was to not physically and permanently impair the birds though most will never be free again since they have been crippled prior to coming to the Raptor Center. Thus, a method that produced a high mitotic index yet did not injure the birds during the procedure was used (Sandes 1954, Panchenko 1970). It entailed injecting a nonpoisonous mitotic arrester (Colcemid, demecolcine) which prevents the formation of the mitotic apparatus required for normal cell division (Brinkley et al. 1967). This procedure allowed for collecting cells that had their chromosomes distinctly formed and separated, easily counted, and then laid out in a distinctive arrangement known as a karyotype.

## Materials and Methods

The two birds used in this study were residents in the Avian Sciences' Raptor Center and were either mature adults or just recently matured birds. The dosage was 1 ml of 0.05% Colcemid per 680 gms bodyweight (Jensen 1967). The calculated amount was injected intravenously using the brachial vein crossing over the phalangeal joint. After 50 minutes, growing body feathers were pulled, the pulp was removed from the base using forceps, and it was put into a preheated 0.45% trisodium citrate solution with 0.001% colchicine final concentration added for additional mitotic arresting. The tissue was left in this hypotonic solution (at 40°C) from 20 to 30 minutes, depending on the age of the bird (a longer time for older birds). The feather pulp then was re-

moved with forceps from the hypotonic solution and placed into freshly made fixative (50% acetic acid). The tissue was allowed to remain in the fixative at last 30 minutes and no longer than one hour. The tissue was placed on a cleaned slide and macerated with a scalpel. Each slide and coverslip was cleaned with Comet prior to use and rinsed with 2X distilled water. After a sufficient suspension was produced, a drop of the solution was rolled onto another precleaned slide and covered with a coverslip, and the tissue was squashed.

For uniformity in the squash technique, a "squash box" was constructed. It was made of plastic with a square section in the center where the slide was secured. A plastic lid fit over the slide, and a clamp was used to apply pressure to the lid that was transferred to the slide under the lid. This method dispersed the cells into a single layer. After squashing, each slide was put into a dry ice-100% ethanol (EtOH) bath that had been sitting for 30 minutes. The slides were left in for a few seconds so that the coverslips could be flicked off with a razor blade leaving the tissue intact on the slide. The slides were then transferred into 100% EtOH for 5 minutes, and then into preheated 1N HCl (56–58°C) for 6 minutes. It was imperative that the temperature be controlled, or the spreads would not stain properly. The slides were then rinsed in running tap water for 5 minutes, and finally rinsed in distilled water. They were stained with normal Giemsa for 15 to 20 minutes, rinsed, and air dried. Clean coverslips were mounted with piccolyte.

### Observations and Discussion

One of the most easily seen characteristics of chromosomes is their attachment during mitosis at their centromeres. Many researchers have described chromosomes using the position of the centromere as a central focal point. To bring a consistency in comparison of the various reports on chromosomes, the Denver Study Group devised a mathematical formula for determining the location of the centromere of the chromosomes (Levan et al. 1965).

The analytic procedure consisted of measuring the long and short arms of the chromosomes and averaging the pair, then using the formula:  $100s/l+s$ , where  $s$  = the short arm of the chromosome and  $l$  = the long arm of the chromosome. Levan et al. (1965) formulated a table relating the results that made it possible to find the centromere locations of the chromosomes of these two karyotypes (Table 1).

Both sexes of *Buteo jamaicensis* had variable numbers of chromosomes, but the number which occurred most frequently was 34 pairs ( $2n = 68$ ). Accordingly, the observations and discussion are based on this number.

The results of the Red-tailed Hawks for the first thirty pairs are shown on Table 2. As could be seen in Table 2, all but eight pairs did not exactly correspond, though only four were not close in their location of the centromere.

The Red-tailed Hawk karyotype appeared to have mainly terminal point (T) (41.2–44.0%) and median region (m) (35.3–38.2%) chromosomes. The submedian (sm) constituted the third largest group (20.6–23.5%) with median point (M) and subterminal (st) chromosomes each making up 2.9%. The most interesting aspect of this karyotype was the small number of microchromosomes of which most other birds, notably the domesticated species, have such a large number that it is difficult to count. In descending order of size, pair number four were believed to be sex chromosomes. The male had a homogametic pair (figure 2); the female had a heterogametic pair (figure 4).

Renzoni and Vegni-Talluri (1966) examined karyotypes of several raptorial species,



Table 1. Centromere location and centromeric index (i)

Nomenclature	i
M	50.0
m	47.5 45.0 42.5 40.0 37.5
sm	35.0 32.5 30.0 27.5 25.0
st	22.5 20.0 17.5 15.0 12.5
t	10.0 7.5 5.0 2.5
T	0.0

The terms used herein are:

Term	Location	i value
M	median point	50.0
m	median region	47.5-37.5
sm	submedian region	37.5-25.0
st	subterminal region	12.5-25.0
t	terminal region	2.5-12.5
T	terminal point	0.0

including the Common Buzzard (*Buteo buteo*). The diploid number of chromosomes in the Common Buzzard was found to be 68; the sex chromosomes were the fourth pair. These findings were very similar to those on the Red-tailed Hawk data in this investigation.

### Conclusion

In the Red-tailed Hawk, chromosome numbers ranged from 32 to 36 pairs, but the majority had 34 pairs ( $2n = 68$ ). This is an adequate estimate of the chromosomal number for this species though it is by no means unequivocal.

The most common sex-determining method used currently involves the use of weight since the female is usually the heavier. However, other methods are becoming available. Dr. Arthur Risser, Jr., is examining the excrement of birds for steroid levels (Risser 1977), a method which may prove successful but requires use of radioactive

Table 2. Data on the female Red-tailed Hawk chromosomes

l	s	i	term
1.35	0.9	40.0	m
1.4	0.7	33.3	sm
1.2	0.7	36.8	sm
(Z)1.25	0.55	30.6	sm
(W)0.7	0.4	36.4	sm
1.2	0.68	36.2	sm
0.725	0.7	49.1	m
0.8	0.55	40.7	m
0.95	0.25	20.8	st
0.65	0.45	40.9	m
0.6	0.4	40.0	m
0.575	0.4	41.0	m
0.55	0.4	42.1	m
0.55	0.3	35.3	sm
0.4	0.3	42.9	m
0.35	0.3	46.2	m
0.35	0.3	46.2	m
0.4	0.2	33.3	sm
0.3	0.2	40.0	m
0.35	0.15	30.0	sm
0.3	0.2	40.0	m
0.45	0.0	0.0	T
0.45	0.0	0.0	T
0.45	0.0	0.0	T
0.45	0.0	0.0	T
0.4	0.0	0.0	T
0.35	0.0	0.0	T
0.35	0.0	0.0	T
0.35	0.0	0.0	T
0.3	0.0	0.0	T
0.25	0.0	0.0	T

material. Cultured white blood cells could also be used, together with chromosomal spreads from them, but would require culturing media and antibiotics. The method described in this report utilized a minimum of expensive equipment and fairly easily obtainable chemicals, except for the mitotic arrester. The technique could be handled in the field though results would be better in a clean laboratory. The time involved in making the slides, from injection to permanent mounting, was relatively short, about 3 to 4 hours.

#### *Acknowledgment*

This work was supported in part by a grant (W54R6-5) from the Wildlife Management Branch of the California Department of Fish and Game.

Table 3. Data on the male Red-tailed Hawk chromosomes

l	s	i	term
1.45	0.75	34.1	sm
1.15	0.8	41.0	m
1.2	0.6	33.3	sm
(Z)1.0	0.5	33.3	sm
1.0	0.75	42.9	m
0.95	0.75	44.1	—
0.8	0.4	33.3	sm
0.5	0.45	47.4	m
0.5	0.45	47.4	m
0.6	0.3	33.3	sm
0.45	0.35	43.8	m
0.5	0.3	37.5	sm
0.45	0.35	43.8	m
0.45	0.3	40.0	m
0.4	0.3	42.9	m
0.45	0.2	30.6	sm
0.35	0.25	41.7	m
0.6	0.0	0.0	T
0.3	0.3	50.0	M
0.3	0.25	45.5	m
0.3	0.25	45.5	m
0.3	0.2	40.0	m
0.5	0.0	0.0	T
0.5	0.0	0.0	T
0.5	0.0	0.0	T
0.4	0.0	0.0	T
0.35	0.0	0.0	T
0.25	0.0	0.0	T
0.2	0.0	0.0	T
0.2	0.0	0.0	T

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Figure 1. Chromosomal spread of male Red-tailed Hawk (*Buteo jamaicensis*) 6,550 X



Figure 2. Karyotype of male Red-tailed Hawk (*Buteo jamaicensis*) 7,960 X

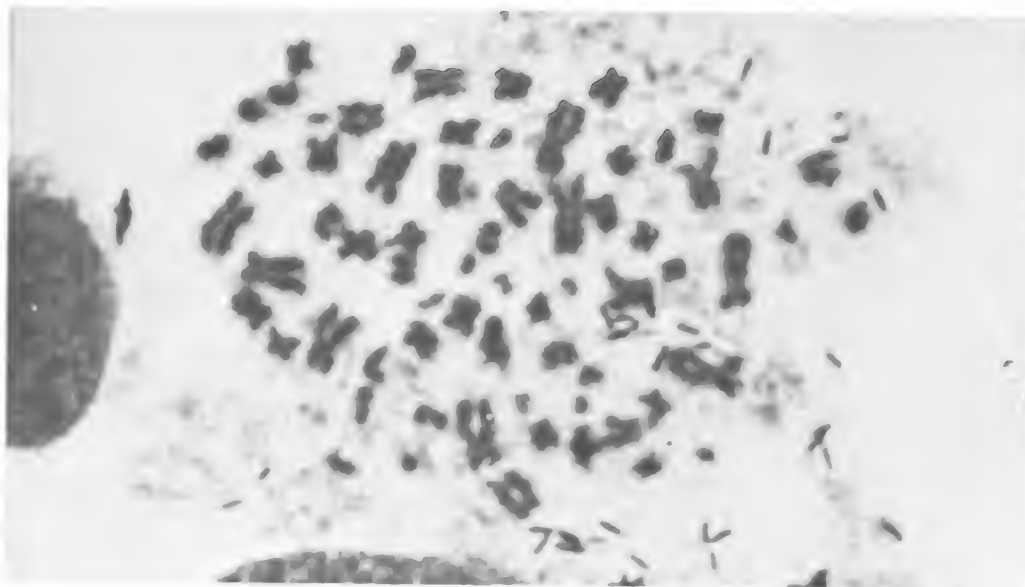


Figure 3. Chromosomal spread of female Red-tailed Hawk (*Buteo jamaicensis*) 7,670 X

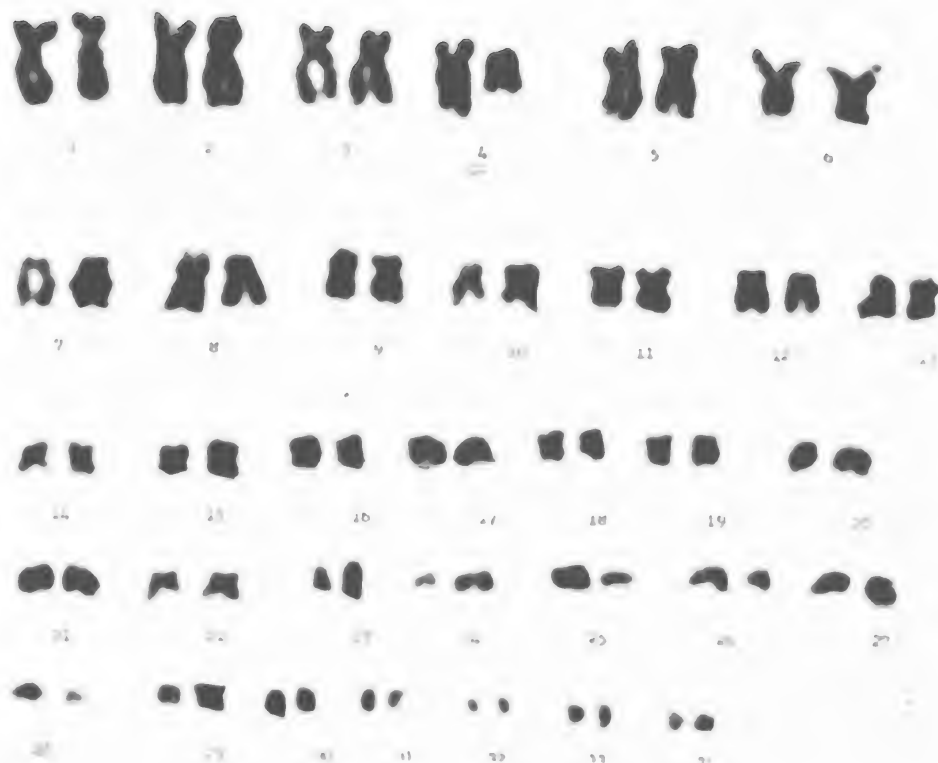


Figure 4. Karyotype of female Red-tailed Hawk (*Buteo jamaicensis*) 7,280 X

## RECENT BREEDING SUCCESS OF RICHARDSON'S MERLIN IN SASKATCHEWAN

by

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### *Abstract*

Records for 96 nestings of the Merlin (*Falco columbarius richardsonii*) in Saskatchewan from 1970–77 were analyzed. An average of 4.0 yg./pair were raised by 47 successful pairs. Current reproductive levels in Saskatchewan indicate that the recent concern over *F.c. richardsonii* in comparison to the other two subspecies is perhaps unwarranted.

### *Introduction*

The reproductive success of Merlins nesting in the grasslands of the Great Plains is reported to have decreased during the period of 1950–69 as compared to pre-1950 levels (Fox 1971). This decrease was accompanied by a decrease in the weight of eggshells. These changes, as well as the disappearance of a small, well-studied population near Kindersley, Saskatchewan, have resulted in much concern over the status of the Merlin (*Falco columbarius richardsonii*) found in the Great Plains area (Trimble 1975).

Recently a small breeding population of this Merlin established itself in the city of Saskatoon, a fairly high density of nesting Merlins was found on a segment of the North Saskatchewan River, and Merlins were found nesting successfully again near Kindersley. These findings prompted a study of the present population status of this bird in Saskatchewan.

### *Methods*

Breeding data were collected for Merlins nesting in southern Saskatchewan for the period 1970–77. Two major study areas were established, one in the city of Saskatoon (1972–77) and the other along a 40-km stretch of the North Saskatchewan River near Saskatoon (1975–77). The data from our work in these two areas were supplemented by information from the Prairie Nest Records Scheme and reports from private individuals.

Pairs of Merlins were located in the city each year by visiting previously known nest sites and following up reports of Merlins seen in the city. Merlins nesting in the city were intensively studied throughout the breeding season (1973–77). The river survey was conducted primarily by canoe. An initial survey was made in early May to locate potential breeding birds and a second was made in late May, during incubation, to confirm the location of the nest sites. The nests were generally not climbed at these times. A third trip to band young and determine reproductive success was made in late June or early July when the young were 2–4 weeks old.



Only sites where Merlins were known to have laid eggs or were actively defending a nest late in the season (when eggs or young would be expected) were included in our total of known nestings. Pairs which had fledged an unknown number of young when visited at banding time were termed successful but were not included in the calculation of production. Nesting attempts that were known not to have fledged any young were termed unsuccessful.

### Results

The nest records of the past eight years indicate that Merlins currently breed throughout southern Saskatchewan where there is suitable habitat (fig. 1). Merlins (*F.c. richardsonii*, according to the criteria of Temple 1972a) were found nesting as far north as the southern fringes of the boreal forest northeast of Prince Albert, Saskatchewan. In that area, and in Saskatoon, most of the nests were in old Common Crow (*Corvus brachyrhynchos*) nests located in tall spruce (*Picea* sp.). Along the North Saskatchewan River, the most common nest situation was a Crow or Black-billed Magpie (*Pica pica*) nest in small willows (*Salix* sp.) 2–4 m. high. In other areas, nests were generally located in magpie nests in larger deciduous trees (usually *Populus* sp.). Most of the nest sites were located along major drainage systems (fig. 1).

Table 1 summarizes the breeding data for 1970–77. An average of 4.0 young/successful pair were produced. Three of the unsuccessful nests were in Saskatoon. These nest trees had been climbed during egg-laying and/or incubation. Another brood of 5 young died of starvation at about 3½ weeks of age after the adults disappeared. It is possible that the adults were shot as the nest was adjacent to an area frequented by many people, and both adults were unusually vocal and aggressive.

Breeding densities were found to be relatively high in our two study areas. Merlins nesting in Saskatoon nested as close as 1.8 km apart. The average distance between four successful urban nests found in 1976 was 3 km. The minimum distance between

Table 1. Breeding data for 1970–1977.

Year	Known Nestings	Known Successful	Known Unsuccessful	Unknown Outcome	Known Production Per Successful Pair <sup>1</sup>
1970	3	—	—	3	—
1971	3	—	—	3	—
1972	11	8	2	1	34/8 = 4.3
1973	9	4	1	4	12/3 = 4.0
1974	12	8	—	4	25/6 = 4.2
1975	17	10	1	6	26/6 = 4.3
1976	14	12	—	2	36/10 = 3.6
1977	27	19	1	7	54/14 = 4.2
TOTAL	96	61	5	30	187/47 = 4.0

<sup>1</sup>Includes 4 nests from which eggs were collected for pesticide analysis in 1972 and 1973. Only successful nests where the exact number of advanced young were known were used to calculate production.

breeding pairs recorded on the North Saskatchewan River was 2.5 km. The age of males was not determined at all nest sites, but the occurrence of males in immature plumage at four successful nests suggests that a significant proportion of males breed in their first year.

### Discussion

*Historical Perspective.* Prior to the coming of settlers, the major nesting habitat of the Merlin on the Canadian prairies was probably restricted to the tree-lined river systems. With the advent of farming in southern Saskatchewan in 1880s, prairie fires were controlled and shelterbelts planted eventually providing new nesting habitats. In these early years native grasslands were more extensive than they are now and provided excellent habitat for typical prey species (Fox 1964; Hodson 1976, 1978). About two-thirds of the total land area of southern Saskatchewan is presently cultivated (Shields et al. 1970). The gradual loss of native prairie (Trimble 1975) and destruction of nesting trees in old shelterbelts by cattle (Fox 1971) have been regarded as major reasons for the disappearance of nesting Merlins in these types of situations. Fox states that five out of six sites occupied at Kindersley, Saskatchewan, in 1960 were unsuitable for nesting by 1962. Whether the decrease in the Kindersley population was due primarily to habitat changes, decreased production due to pesticide contamination, or other reasons is unclear.

Our data include five recent nestings from the Kindersley area, (2 in 1972, 1 in 1975, and 2 in 1976) all of which were successful, although there has been no attempt to do an intensive survey. A determination of the size of the present Kindersley population in comparison to 1950 levels would provide an interesting test of the hypothesis that habitat changes were the major reason for the decline in this population. Although the major Merlin population has probably always been associated with the river systems, there is no adequate historical data to allow comparison with the present population nesting along the river.

*Present Status.* The production of young by the 47 successful pairs in Saskatchewan from 1970 to 1977 with known numbers of nestlings (4.0 yg./nest) is higher than that reported by Fox (1971) for 17 nests on the Canadian prairies from 1950 to 1969 (2.7 yg./successful nest) and Fyfe (Hodson 1972) for 14 nests in Alberta and Saskatchewan in 1968–69 (3.1 yg./successful nest). It is comparable with pre-1950 reproductive levels of 3.1–4.3 yg./successful nest reported by Fox (1971).

The breeding density along the North Saskatchewan River indicates a rather large breeding population if it is typical of similar habitat elsewhere in the province. The recent appearance and expansion of the urban population in Saskatchewan and the reappearance of breeding pairs in the Kindersley area both suggest an expanding population. An intensive study of the birds of the Rosetown-Bigger district between 1968 and 1976 failed to reveal any breeding Merlins (Renaud & Renaud 1975). During 1976 and 1977, however, a total of seven nesting pairs were found in this area. Fyfe (1976) has recently concluded that *F.c. richardsonii* is increasing on the Canadian prairies. The first records of Merlins breeding in Montana have recently been reported (Ellis 1976). Further investigation is needed to clarify the status of the Merlin in the southern Great Plains.

The conclusion (Trimble 1975) that *F.c. richardsonii* is in greater trouble than the other subspecies is, in our opinion, unwarranted on the basis of its current status in Saskatchewan. The only recent account of the breeding status of taiga nesting Merlins (*F.c. columbarius*) is on 20 nests studied in Newfoundland in 1969 which produced

3.0 yg./successful nest (Temple 1972b). Substantial recent data on taiga Merlins throughout the rest of their range is unavailable. The taiga Merlin, since it is the most migratory of the three North American subspecies, bears close watching if the current hypothesis that problems of pesticide contamination are primarily associated with wintering populations in Latin and South America is true.

### *Acknowledgments*

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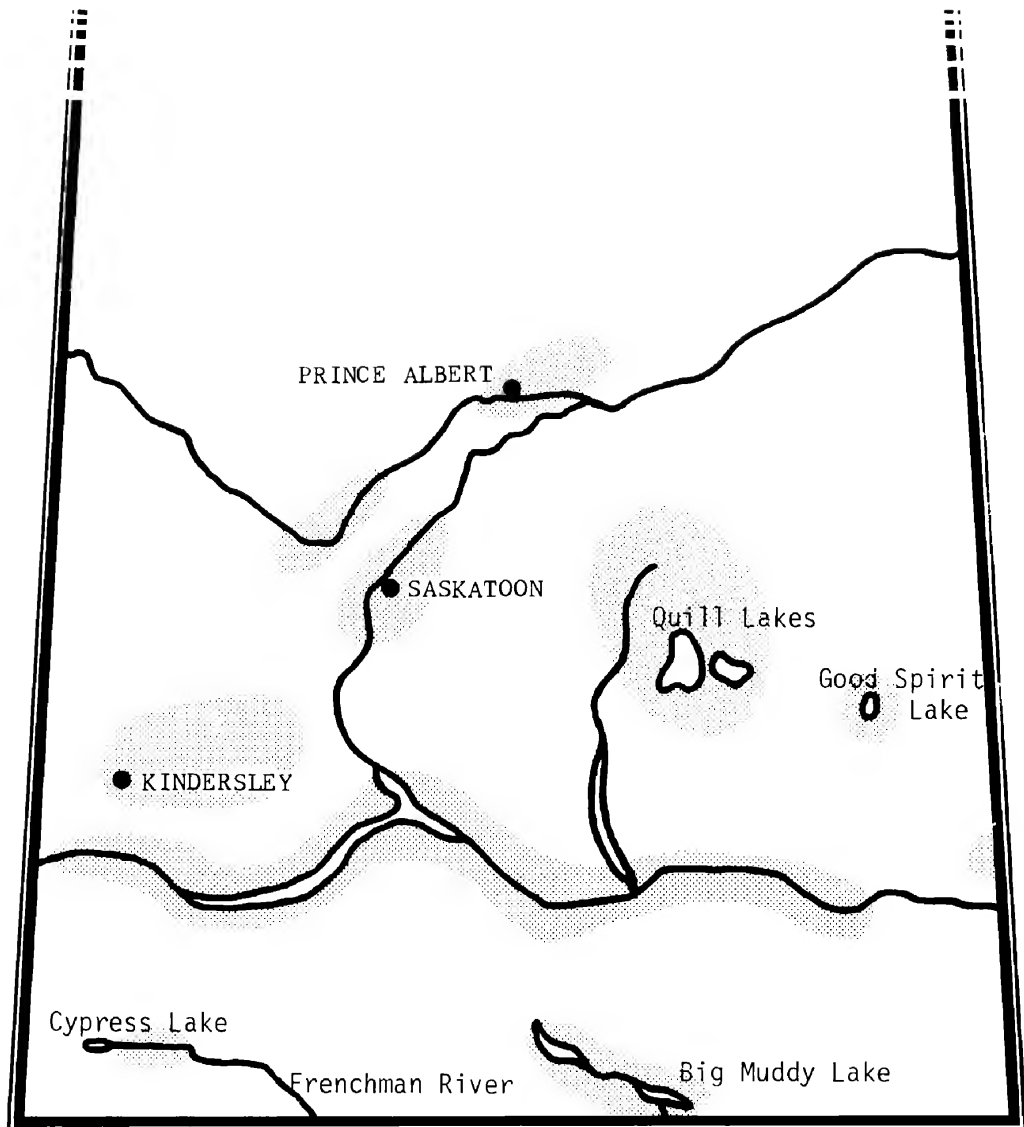


FIGURE 1. Map of southern Saskatchewan with major drainage systems. The stippled areas indicate locations of nesting sites active between 1970 and 1977.

# A CAR SURVEY OF RAPTORS IN SOUTHEASTERN IDAHO 1974-1976

by

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A car survey of raptors was conducted over a 187 km route in southeastern Idaho during the non-nesting seasons from November 1974 to May 1976. The American Rough-legged Hawk (*Buteo lagopus*) was most numerous, followed in abundance by the American Kestrel (*Falco sparverius*) and the Golden Eagle (*Aquila chrysaetos*). Perched raptors were commonly on the tops of power poles. The Marsh Hawk (*Circus cyaneus*), the American Rough-legged Hawk, and the American Kestrel were most numerous in agricultural lands while the Prairie Falcon (*Falco mexicanus*) and the Golden Eagle were seen most often in the mouths of river valleys around native vegetation.

## Introduction

Car surveys for raptors allow collection of information on distribution and relative density estimates over a fixed route (Gier 1970). These data can be used to investigate population changes from year to year as in Johnson and Enderson (1972) or from season to season. Information on perch preference may help land managers to choose the kinds and placement of new perches that might improve raptor habitat.

The present study was designed to produce information on relative densities of raptors during the nonbreeding season on a National Environmental Research Park (NERP) in southeastern Idaho, the Idaho National Engineering Laboratory (INEL) Site.

## Study Area

The 2315 km<sup>2</sup> study area is a cool desert (Odum 1971) with an average elevation of 1524 m. Big sagebrush (*Artemisia tridentata*)–grass vegetation types are predominant (Harniss and West 1973), and Utah junipers (*Juniperus osteosperma*) occur sporadically over portions of the site. The INEL Site is bordered on the northwest by the Lost River and Lemhi mountain ranges and the Big Lost River, Little Lost River, and Birch Creek valleys (fig. 1). The characteristic vegetation of the study area is interrupted by agricultural lands in the Little Lost River valley and on the northeastern edge of the INEL Site.

## Materials and Methods

The raptor survey, by automobile, began on 20 November 1974. Each survey was begun after 0800 (MST) and all surveys were completed by 1435. They were completed only on calm days during which little precipitation occurred. Surveys were conducted twice a month; but they were not evenly spaced throughout the month because of variations in weather.

The survey route circled the western portion of the INEL Site and was 187 km long. It was run at an average speed of about 45 kph, and all raptors observed were

recorded; direction was alternated on each survey. In all, 32 surveys were conducted: 14 from 20 November 1974 to 25 May 1975 and 18 from 30 August 1975 to 29 May 1976. A total of 5984 km were driven during the survey, and more than 130 hours were spent in this pursuit. The survey was discontinued from 25 May 1975 to 30 August 1975 and on 29 May 1976 as most migrant raptors had left the study area and nesting raptors were sedentary.

Although 12 species of raptors were observed, 7 were observed infrequently enough to be incidental sightings; thus records on perch preference and location are reported herein on the most frequently encountered species.

A problem arising in this type of study is that many observations are actually re-sightings; the same individuals may be seen more than once on the same survey day. Since my survey route was large (about 4 hours/survey), birds probably did not move far enough to be recounted during the same survey. Similarly, I drove faster than others (Craighead and Craighead 1956; Marion and Ryder 1975) and reduced the chance that birds were resighted. Unfortunately, this speed also decreased the probability of sighting raptors.

Marion and Ryder (1975) report that over half of all raptors were flying when they were first seen. However, with the exception of the Marsh Hawks, raptors were usually seen perched on the INEL Site. This probably reflects the fact that I paid particular attention to potential perching sites.

### *Results and Discussion*

Most birds were seen in the first two hours of each survey with the exception of the American Rough-legged Hawks. These birds were seen anytime in the survey although usually before 1200.

Marsh Hawks were rarely seen on the survey route during the winter but began arriving on the INEL Site in March. A total of 33 (0.18/km) were seen, mostly in April, May, and August (23). They were probably migrating across the study area (table 1). Most Marsh Hawks were seen in areas surrounded by farm land, and perhaps the hay fields offered good hunting areas for them. Additionally, the even, low vegetation of the agricultural lands make low-flying birds easier to see.

American Rough-legged Hawks were the most numerous wintering raptors on the study area, and a total of 288 (1.54/km) were recorded. They were first noted on the survey route in mid-October and were absent by mid-April, although a few remained later in the year. There was a significant difference in the number observed on 14 surveys in 1974–1975 (100) and on 13 surveys in 1975–1976 (170) which began on 19 November and continued through May (Group Comparison  $t$ ;  $t = 1.91$ ,  $p < .05$ ); however, the reasons for this difference are not apparent. The highest number observed on the INEL Site in one survey was 37 on 29 January 1976. A significant percent were perched on power poles (75.1%) (Clopper and Pearson Chart for confidence belts of proportions,  $p < .05$ ; Dixon and Massey 1957), and most (149) were on the top. Fenceposts and cross arms on power poles were almost equally selected, but few hawks were seen on the ground (probably since the height of the vegetation hindered observation) or in trees (few of the total available perches were trees). Marion and Ryder (1975) also detected a predisposition of American Rough-legged Hawks to perch on power poles. Most surveyed birds were sighted in farming lands, and fewer were seen in the sagebrush flats adjacent to the Birch Creek valley. The portion of the survey route which ran 20 km out on the Snake River Plain had fewest



birds. Since there were adequate perches on the plain, factors other than perch availability must limit distribution of wintering American Rough-legged Hawks in these areas.

Prairie Falcons were seen throughout the year on the study area and nest on and around the INEL Site. They were seen in every month of the survey except December, and a total of 32 (0.17/km) were observed. Six were sighted on 25 October 1975; but no more than three were seen on any other survey. Nearly 94% of the Prairie Falcons were on power poles, although there seemed to be no significant preference for tops or cross arms of the poles (Clopper and Pearson Chart,  $p = .05$  and  $p = .05$ , respectively). Most Prairie Falcons were on portions of the survey route crossing the mouths of the desert valleys.

American Kestrels do not winter on the study area, but 111 were observed in the spring and fall of 1975 and 1976, most in April, May, and September. They were the second most frequently encountered species on the survey route (0.59/km). Significantly more were on the top of the power pole or on wires than on cross arms (Clopper and Pearson Chart,  $p = .05$ ), and 14.7% were on fence posts. Most American Kestrels were seen in farming areas adjacent to the mountain ranges which border the INEL Site. Perches in these areas may have concentrated migrating American Kestrels.

Golden Eagles were seen 44 times (0.24/km) on the survey, most during the winter. Golden Eagles occur on the INEL Site throughout the year, although few remain during the summer. Most were perched on power poles (73.7%) although nearly as many were on the cross arms as on the pole tops. Golden Eagles were seen perched on the ground (15.8%) more frequently than any other raptor, perhaps because they were more visible. However, Enderson et al. (1970) found that the majority of Golden Eagles were on the ground or on fenceposts on an aerial survey in Colorado. More Golden Eagles were seen in the mouths of the river valleys than in other areas.

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Table 1. Most frequently observed raptors sighted while driving a 187-km survey route on the INEL Site, 1974-1976.

	Marsh Hawk ( <i>Circus cyaneus</i> )	American Rough-legged Hawk ( <i>Buteo lagopus</i> )	Prairie Falcon ( <i>Falco mexicanus</i> )	American Kestrel ( <i>Falco sparverius</i> )	Golden Eagle ( <i>Aquila chrysaetos</i> )
1974					
11-20	0	8	2	0	4
12-6	0	6	0	0	1
12-16	0	11	0	0	0
12-23	0	5	0	0	1
1975					
1-17	0	11	1	0	8
2-2	0	8	0	0	0
2-17	0	15	2	0	5
3-2	0	11	0	0	1
3-16	2	7	1	0	0
3-31	0	10	1	0	2
4-13	10	7	1	2	1
4-29	3	0	1	27	0
5-10	2	1	0	14	0
5-25	1	0	0	5	0
8-30	5	0	1	1	1
9-15	0	0	1	26	0
9-28	3	0	3	10	0
10-12	1	2	0	8	0
10-25	0	16	6	0	1
11-19	0	15	3	0	4
11-28	2	19	1	0	0
12-14	0	10	0	0	3
12-28	0	12	0	0	2

Con't.

Table 1, Con't.

1976					
1-10	0	18	0	0	5
1-29	1	37	1	0	1
2-14	0	25	0	0	4
3-4	0	17	1	0	0
3-22	1	9	1	0	0
4-4	0	8	1	0	0
4-20	0	0	2	12	0
5-5	0	0	1	5	0
5-29	2	0	1	1	0
TOTAL	33	288	32	111	44

Table 2. Perch preference of selected raptors observed over a 187-km survey route on the INEL Site, 1974-1976.

Perch	American Rough-legged Hawk ( <i>Buteo lagopus</i> )	Prairie Falcon ( <i>Falco mexicanus</i> )	American Kestrel ( <i>Falco sparverius</i> )	Golden Eagle ( <i>Aquila chrysaetos</i> )
	%	%	%	%
Power Pole				
Top	58.0 (149)	51.6 (16)	45.1 (46)	39.5 (15)
Cross arm	17.1 (44)	41.9 (13)	4.9 (5)	34.2 (13)
Wire	0.0 (0)	0.0 (0)	30.4 (31)	0.0 (0)
Fencepost	16.3 (42)	3.2 (1)	14.7 (15)	5.3 (2)
Tree	2.3 (6)	3.2 (1)	1.0 (1)	5.3 (2)
Ground	6.2 (16)	0.0 (0)	3.9 (4)	15.8 (6)
TOTAL	99.9 (257)	99.9 (31)	100.0 (102)	100.1 (38)

Craig- 10

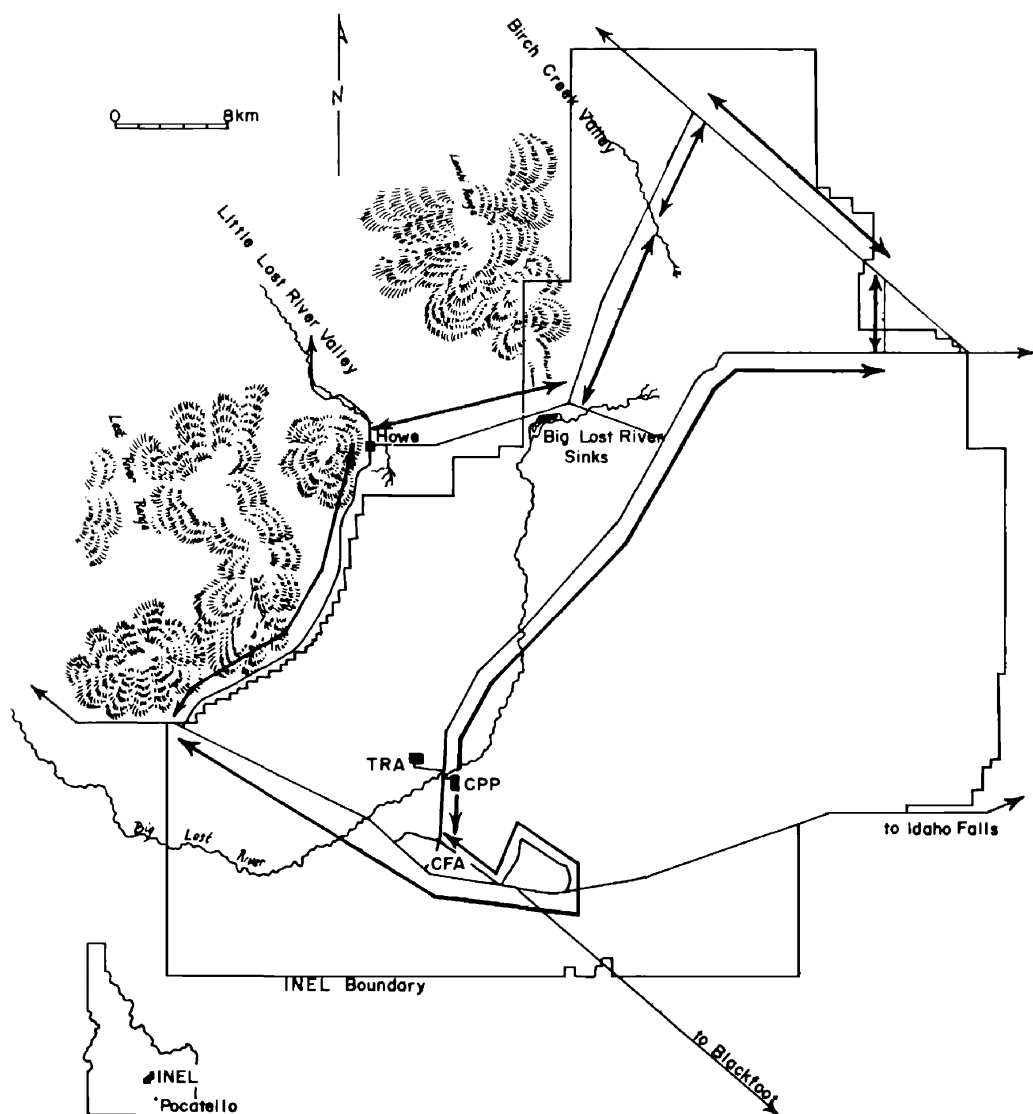


Figure 1. Map of the INEL Site showing the car survey route used in 1974-1976.

## PEREGRINE PRAIRIE FALCON INTERACTION

by

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Peregrine Falcons (*Falco peregrinus*) are normally involved in courtship and nest-site selection during February in much of California. On 3 February 1975, at 1400 PST in Sonoma County, California, I observed an agonistic interaction between a resident pair of adult Peregrines and an intruding competitor for prey and nest-territories, an adult female Prairie Falcon (*Falco mexicanus*). The interaction occurred above an east-west aligned canyon at an elevation of 670 meters. All observations were made through binoculars from the southern ridge of the canyon at distances of 300 to 500 meters. Rain fell intermittently, and snow persisted on higher ridges. I have no reason to suspect that my presence had any effect on the falcon behavior. In this area Peregrines have nested from 1969 to 1975 (Thelander 1975) while Prairies are rarely observed and are not known to breed. In 1974, I observed three immature and two adult Peregrines on the northern ridge of the canyon.

The interaction between a female Peregrine and a female Prairie had begun when I arrived. The female Peregrine repeatedly circled to gain height advantage and then made shallow stoops at the Prairie which rolled onto its back with legs extended to defend itself. Contact occurred only when the Prairie grappled from below with the circling Peregrine. Vocalizations occurred throughout the interaction, notably wailing screams during contact. Physical contact between the falcons occurred four times in seventeen minutes of observation. The female Peregrine pursued the Prairie eastward after each contact. Each time the Peregrine returned first, followed within minutes by the Prairie. Neither falcon appeared to have an advantage in flight capabilities. As the Prairie returned a fifth time and approached the female Peregrine, a previously undetected male Peregrine stooped with wings closed from above and struck the Prairie, which did not react quickly enough to roll and defend itself. The Prairie fell immediately, atypically heavily inert, with no sign of life, approximately 215 meters into the canyon below. The male Peregrine soared briefly over the area in which the Prairie fell, and then flew northward out of view. The female Peregrine landed, visibly exhausted, in a tree on the northern ridge. In deference to the female Peregrine, no attempt was made to recover the dead or injured Prairie (difficult terrain and access necessitated disturbance of the Peregrines to recover the Prairie).

Several authors describe interspecific agonistic interactions between Peregrines and such species as Prairie Falcons, Gyrfalcons (*Falco rusticolus*), Lanner Falcons (*Falco biarmicus*), Saker Falcons (*Falco cherrug*), Ravens (*Corvus corax*), Golden Eagles (*Aquila chrysaetos*), and Bald Eagles (*Haliaeetus leucocephalus*) (Cade 1960, Ratcliffe 1962, Nelson 1969, Nelson 1970, von Blotzheim 1971, Porter and White 1973). Cade (1960) mentions that the basic components of agonistic behavior displayed by Peregrines are stereotyped patterns. These authors attribute variation in the intensity of this behavior to (1) individual variation, (2) the proximity of the interaction to the

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nest-site, (3) the frequency of interactions between the species involved, and (4) the period of the annual cycle when the interaction occurs. Rarely has the agonistic behavior been reported to be intense enough to cause death or injury to the individuals involved. The exceptional combination of these factors—(1) an exceptionally aggressive and effective male Peregrine, (2) closeness to the Peregrine nest-site, (3) the scarcity of Prairies in the area of the Peregrine nest-site, and (4) the timing of the Peregrine nesting cycle, nest-site selection—apparently resulted in such an occurrence on this occasion.

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## BOOK REVIEW

**The Ethology of Predation.** E. Curio. 1976. Springer Verlag, Berlin, Heidelberg, New York. 250 pages. 70 figures. \$29.60.

Ornithologists and falconers have always found the subject of predation a fascinating one. Despite the popularity of books depicting predators in action, little has been written on the mechanics of predation. Dr. Curio has done much to redress the balance. This book is one of a series of volumes dealing with zoophysiology and ecology. It is aimed at the serious student who wishes to delve deeper into the way predators behave. The main text is divided into five chapters: Internal Factors, Searching for Prey, Prey Recognition, Prey Selection, and Hunting Prey. Fishes, birds, and mammals are all dealt with under the same heading, which does not make for easy reading. A paragraph on the behavior of the Lanner Falcon may be followed by one on piranha fish.

Dr. Curio relies on examples—and many are given—to make his point. Little space is devoted to discussion. It is interesting to observe that similar characteristics are found in a wide diversity of species. Surprise is probably the hunter's most effective weapon. Stealth, stamina, speed, and even deceit are all valuable attributes.

Hunger is not the sole motivation for hunting although an important factor. The sick, the aged, and the aberrant are always at more risk than the healthy. Often their disabilities are not discernible to the human eye. Selection is what predation is about.

Perhaps the book's greatest virtue is the 24-page list of references to articles and papers which would prove invaluable to anyone doing research work. The price of the book is excessive by any standards, but the wealth of information contained is undeniable.

R. B. Treleaven

## BOOK REVIEW

**Owls by Day and Night.** H. A. Tyler and D. Phillips. 1978. Naturegraph. 208 pp., tables, maps, 16 color plates, numerous black and whites. Buteo Books, Vermillion, SD 57069; paper \$4.95; cloth \$7.95.

One is inclined to groan at the mention of yet another book on North American owls, but this one, though semipopular, is a pleasant surprise. Mr. Tyler as a boy accompanied his father and Arthur Cleveland Bent as they collected material for the latter's classic *Life Histories*. Tyler has done his homework diligently. For example, for such a little known bird as the Great Gray Owl one would expect a short, perfunctory account; instead, the periodical literature has been combed for the few published encounters with this owl in Yosemite and Montana, and then Robert Nero of Canada was persuaded to submit some of his as yet unpublished findings. Tyler writes with style and verve.

Don Phillips, the second author, is actually the artist, though some of his observations are included. His paintings and drawings, though a bit stylized, are dramatic and adequate. About a third of the text discusses the general characteristics of owls; the remainder comprises species accounts. Recommended!

Dean Amadon



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